New Scientist

WEEKLY 14 June 2025

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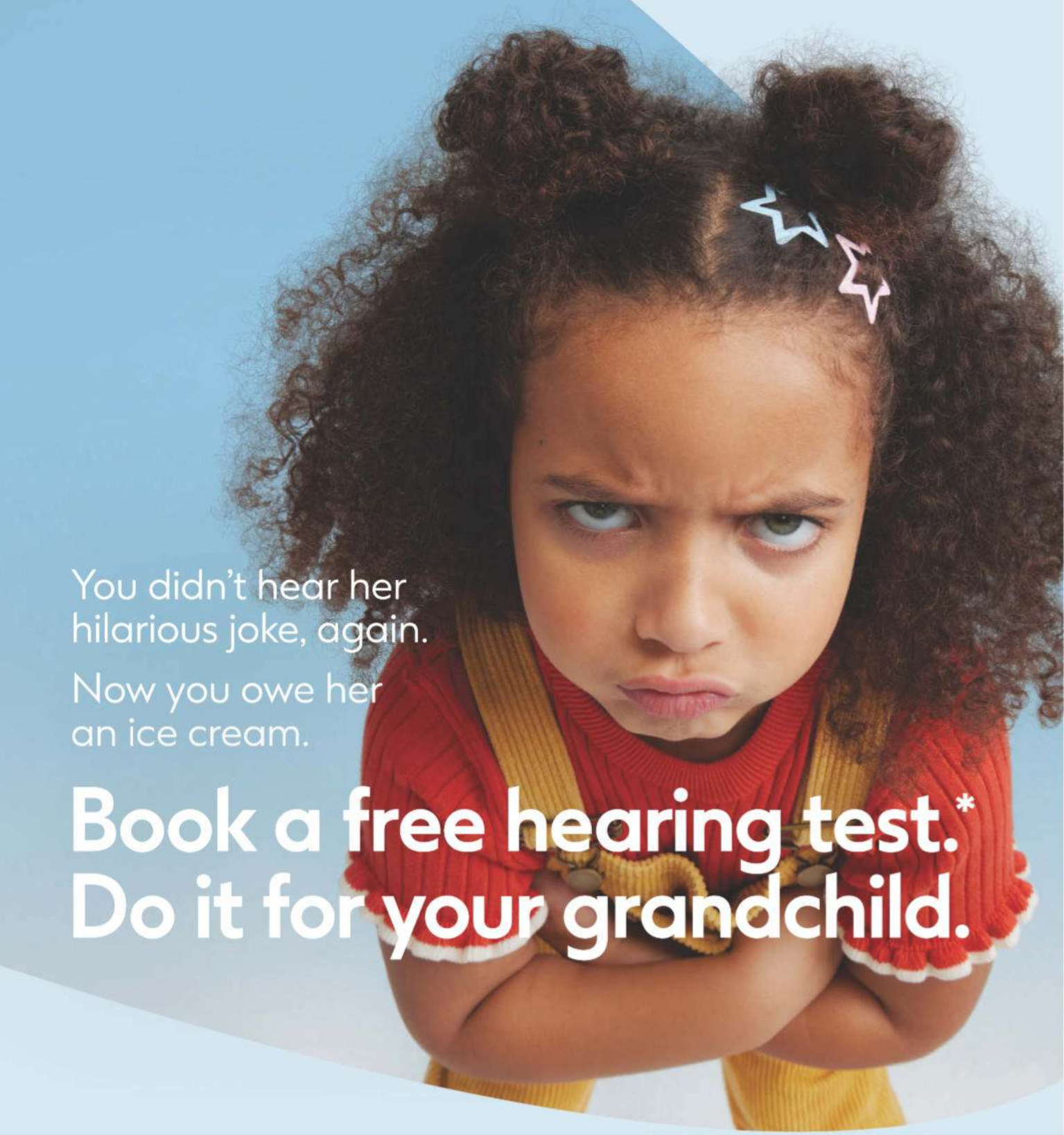

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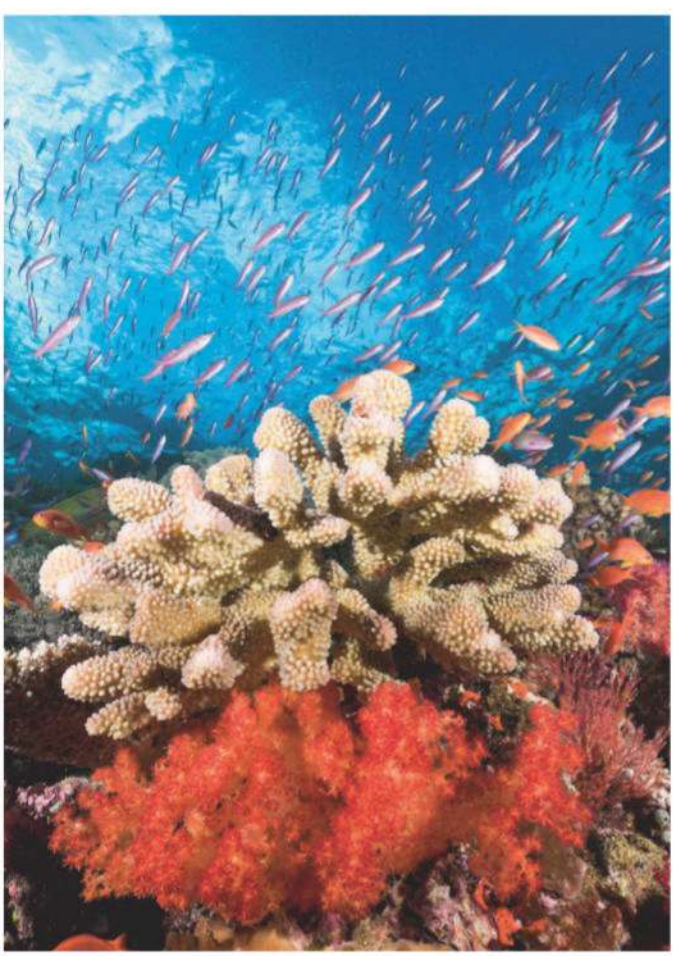

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Elsewhere on New Scientist

NS Live

Chris Packham in conversation

Join Chris Packham in conversation with a *New Scientist* expert on 19 October at London's ExCel centre, as he discusses his career as a naturalist, nature photographer, television presenter and author. Packham is known for his work on *The Really Wild Show* (1986–1995) and the BBC's *Springwatch*, *Autumnwatch* and *Winterwatch* series since 2009.

newscientist.com/nslive

Tour

Human origins and gentle walking in prehistoric south-west England

From complex Iron Age hillforts to ancient stone circles, immerse yourself in the early human periods of the Neolithic, Bronze Age and Iron Age on this gentle walking tour. Visit several National Trust, English Heritage and UNESCO World Heritage Sites, including Stonehenge, Old Sarum, Avebury and Mwaiden Castle. This five-day tour starts on 14 July and costs £1795.

newscientist.com/tours

Podcast

The world, the universe and us

The team discusses the finding that the moon has significant amounts of platinum deposits, and the legality of mining it. Explore how brain pathways help us sort imagination from reality. Plus, find out how living worms come together to form giant towers.

newscientist.com/pod

SHUTTERSTOCK/PAJOR PAWEL

Stone circles Visit ancient sites like Stonehenge in Wiltshire, England

Circular city See how Amsterdam is transforming its economy

Video

How Amsterdam will transform into a circular city by 2050

Amsterdam has set itself the goal of having a fully circular economy by 2050. To find out more, *New Scientist* paid a visit to the city and, in partnership with researchers from the AMS Institute for Advanced Metropolitan Solutions, explored the work going on there – and what it can teach us about circularity.

youtube.com/newscientist

Newsletter

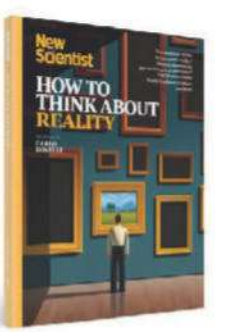
Launchpad

The existence of a hypothetical Planet Nine in the outer reaches of our solar system has been hotly debated by astronomers. One of the main issues: we don't know how it could have got there. Now, a new model of the early solar system has finally explained in detail how this planet could have formed.

newscientist.com/sign-up/launchpad

Podcast

"For every human on the planet, there are apparently 60 billion nematodes"



How to think...

In the second issue of our new *How To Think About* series, we are diving into the mind-bending concept of reality, with the world's best scientists and philosophers as our guides. Together, we will explore groundbreaking ideas that bring us closer than ever to unravelling the true nature of the universe.

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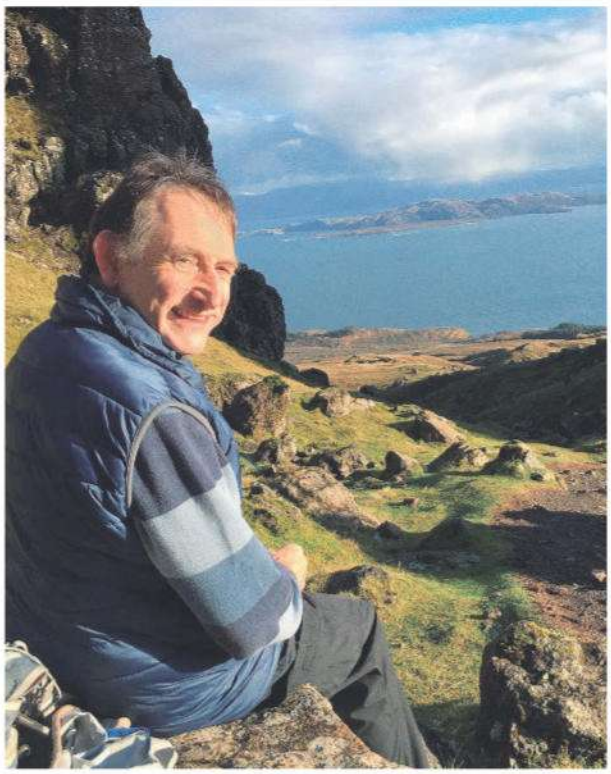
People can be a happy place.

Jo's four children are his. His world is never bigger than with them. Out on a hike. Everyone together. It's when Perthshire is at its most beautiful.

But his favourite bit? When the walk is finally over and the whole family sits down for a proper cup of tea and ever-so-slightly overdone fruit cake.

It's what made his late wife, Sue, happiest. The brood of kids all around her. Stomachs and hearts full. And it's the part he now cherishes most.

That's why he left a gift to Cancer Research UK in his Will.



So more famillies can have more time together.

For **Daniel**, it's been twelve more years with his loved ones - and counting. His Hodgkin Lymphoma diagnosis at just twenty-three was a huge shock. He felt lost, but never alone. His boyfriend Adam holding his hand every step of the way.

After four rounds of chemotherapy and two weeks of radiotherapy, which CRUK pioneered, he was given the all clear.

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War of nerves

The nervous system offers a new – and potentially cheap – route to treating cancer

ONE of the biggest, yet often-overlooked, good news stories of the century so far is how many people now survive cancer. Recent data reveals that today, half of those diagnosed with cancer in the UK will survive for at least 10 years, compared with just a quarter 50 years ago. Similarly, in the US, the cancer mortality rate has declined by 34 per cent over two decades. In Australia, over 70 per cent of people with cancer now survive for at least five years.

Some of these major gains are thanks to declines in smoking and the rollout of national screening programmes for multiple cancer types. But scientific advances in treatment have played their part, too, not least in providing a whole new treatment approach in the form of immunotherapies, which encompass monoclonal antibodies, checkpoint inhibitors, cancer vaccines and more.

But it isn't all good news. Apart from positive advancements, the incidence of cancer is still growing, and there are signs that the rate of improvement in survivability is slowing. If we want to see the dramatic progress we have made so far continue, we may need to look at cancer from an entirely fresh angle.

> "Drugs that target the way cancer and our neurons interact are already showing promise"

Fortunately, the new field of cancer neuroscience may provide exactly that, as we explore in our cover story (see page 30). The discovery that nerves play a critical role in cancer – helping tumours to grow and spread around the body – offers a fresh line of attack. Drugs that target the way cancer and our neurons interact are already showing promise in trials and are beginning to be touted as the next big thing in cancer treatment.

If cancer neuroscience does deliver the next big breakthrough, the drugs themselves might turn out to be surprisingly cheap and accessible – several common beta blockers, for example, are under investigation.

That would be a welcome development, in a world where many of the other new treatments can be prohibitively expensive, and when many difficulties remain in ensuring fair, rapid and affordable access to the best cancer treatments. ▮

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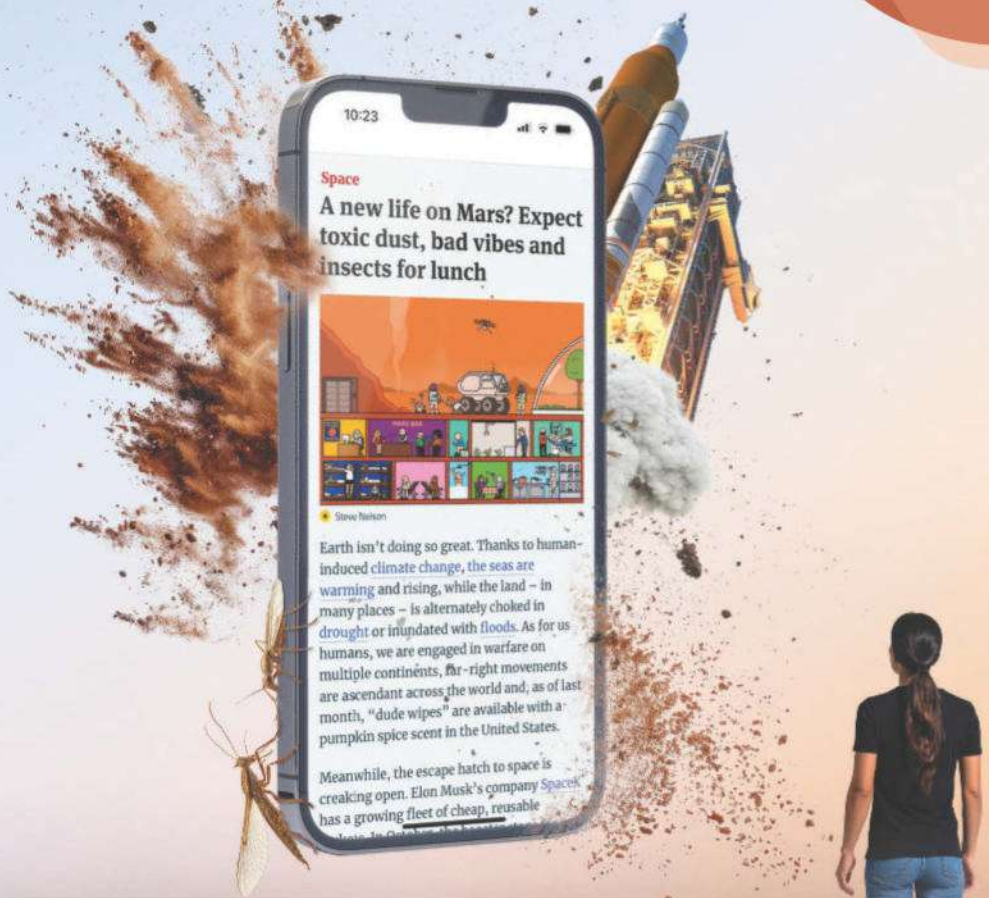
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Space
A new life on Mars? Expect toxic dust, bad vibes and insects for lunch
Steve Nelson
Earth isn't doing so great. Thanks to human-induced climate change, the seas are warming and rising, while the land – in many places – is alternately choked in drought or inundated with floods. As for us humans, we are engaged in warfare on multiple continents, far-right movements are ascendant across the world and, as of last month, "dude wipes" are available with a pumpkin spice scent in the United States.
Meanwhile, the escape hatch to space is creaking open. Elon Musk's company SpaceX has a growing fleet of cheap, reusable

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Inside scoop
How our brains sort imagination from reality **p14**

Collider conundrum
Quantum computers take on particle physics **p17**

Carbon leak
Rivers are releasing ancient carbon into the atmosphere **p18**

Metallic moon
Lunar craters may be full of platinum and other metals **p19**

Crafty cockatoos
Birds find new way to quench their thirst **p19**

VCG/VCG VIA GETTY IMAGES

Technology

Not dancing, but fighting

This kickboxing robot showed off its best moves at the seventh Beijing Academy of Artificial Intelligence conference on 6 June. Wang Xingxing, CEO of UniTree, which created the robot, told the conference it is a step towards creating humanoid robots that can perform full-body movements to help with tasks in homes or factories. He also said that he believes robot fighting will become a popular sport.

Climate change

Europe's forests are in crisis

Extreme weather, pests and overharvesting are turning forest carbon sinks into carbon sources across Europe, undermining a crucial part of countries' net-zero plans, finds **Madeleine Cuff**

A SUDDEN and dramatic decline in the amount of carbon being soaked up by European forests is causing alarm among scientists, with fears that it could undermine efforts to curb global warming.

Europe's forests – which cover around 40 per cent of the continent's land area – are relied on as a source of timber and as a sink for carbon emissions. But that picture is rapidly changing as extreme weather pushes forests to the limits of their endurance.

"Many countries will miss their land use climate targets because of this drop in the sink"

"Many [European Union] countries will miss their [land use climate] targets because of this drop in the sink," says Glen Peters at the CICERO Center for International Climate Research in Norway.

In January, authorities in Finland announced that the country's forest biome had flipped from being a net sink for carbon to a net source. This came a few months after Germany said that its forests are now a net source of carbon emissions, for the first time in the country's history. Meanwhile, in the Czech Republic, forests have been a net source of carbon emissions since 2018.

These are just the most extreme cases. In other countries, the annual carbon drawdown of forests is rapidly declining, even if, overall, they remain a net sink for emissions. In France, for example, the amount of carbon removed by forests has almost halved in just 14 years, from a 2008 peak of 74.1 million tonnes of carbon dioxide per year to 37.8 million tonnes in 2022, according to research published last month. In Norway, forest removal of CO_2 dropped from 32 million tonnes in 2010 to 18 million tonnes in 2022.

"The general trend was quite stable until about 2013-2015-ish, where we see a clear start of the decline of the [forest] sink," says Anu Korosuo at the European Commission's Joint Research Centre in Belgium. "It is quite a general trend. It's not just because of one or two countries – we can see a similar trend in basically all countries that have forests."

Much of Europe's forested land is privately owned and managed commercially. Some of the decline in the sink is attributed to a rise in harvesting, particularly in the aftermath of Russia's invasion of Ukraine in 2022 and the subsequent sanctions applied to Russian timber imports into the EU. In Finland, for example, "the driver is demand for timber and a high level of harvest", says Raisa Mäkipää at the Natural Resources Institute Finland.

KARL ANDER ADAMI/ALAMY

But in other parts of the continent, scientists point to escalating climate impacts as the main reason for the sudden downturn in carbon storage.

Swathes of Europe have been struck by several droughts in recent years, including severe ones in 2018 and 2022, says Wouter Peters at Wageningen University in the Netherlands. His research shows that the 2022 drought triggered a sharp decline in carbon uptake by European forests over the summer months. "We are seeing the instantaneous effects. The trees are stressed," he says.

Storm warning

Even though researchers expected a decline in the European forest sink as the world warms, the scale of the recent downturn has come as a surprise. Researchers didn't think the sink would fall so sharply at this level of warming, says Wouter Peters. "The impact seems to be larger than we expected."

That could be down to the compound effects of repeated droughts occurring in the space of just a few years, alongside other extreme events such as storms that can also wreak havoc in forests. "You don't just have the 2018 drought, but then one in 2021 and another one in 2022," he says. "Our models were not very good at doing the sum of all of them in such a short period."

Rising temperatures are also driving more frequent and

A global problem

Levels of carbon dioxide in the atmosphere are now rising at the fastest rate in history, despite an overall plateauing of greenhouse gas emissions. Scientists blame this acceleration on the weakening of the global land sink, with forests, wetlands and peatlands around the world absorbing carbon at a slower rate than expected, in part due to deforestation, increased emissions from wildfires, and drought.

The problem is most acute in the mid-latitudes. Alongside Europe, boreal forests in Alaska and Canada have also registered a significant decline in the capacity of their carbon sink. But tropical forests have seen a decline in their carbon-storing capacity too, largely due to deforestation and wildfires.

That is a worry for the world's plans to reach net-zero emissions. "In the big global picture, the whole concept of net zero works around forests and ocean taking up a lot of carbon," says Glen Peters at the CICERO Center for International Climate Research in Norway. "If they start to stop taking up the carbon, then that means more of it stays in the atmosphere, and global warming would accelerate."

Finland's forests have switched from a net sink to a net source of carbon

widespread bark beetle outbreaks across Europe, causing huge damage in spruce forests. In the Czech Republic, one of the hardest-hit countries, there have been seven major outbreaks of these beetles between 2018 and 2021.

A waning forest carbon sink threatens the EU's climate goals, which rely on trees to absorb a large portion of ongoing emissions from other sectors of the economy. The EU has been planning to expand this carbon sink to help in the push towards its climate ambitions, aiming for land and forests to remove 310 million tonnes of CO_2-equivalent per year in 2030, up from about 230 million tonnes of removals in 2021.

But according to an analysis published in April, Europe's forest carbon sink is expected to fall short of the 2030 goal by about 29 per cent, with the researchers warning that the capacity of Europe's forests to remove carbon is "progressively deteriorating".

There are actions that can stem the decline. Reducing harvest rates and banning the clear cutting of plantations would help to preserve carbon stocks. Meanwhile, diversifying tree species and leaving some deadwood in forests can improve the health of woodlands, making them more resilient to pests and droughts.

But Wouter Peters says policy-makers are overestimating the amount of carbon that forests can absorb in a warming climate. "For greenhouse gas emissions specifically, our reliance on forests was probably overoptimistic," he says. To deliver on Europe's climate goals, other sectors of the economy will need to cut emissions more rapidly, he says.

Palaeontology

Sauropod dinosaur's last meal reveals that it didn't chew

James Woodford

THE fossilised gut contents of a sauropod dinosaur have been studied for the first time, revealing that the largest land animals that have ever lived were herbivores that swallowed their food whole.

STEPHEN POROPAT

Judy's fossilised gut contents, which included whole leaves

A fossil nicknamed Judy, from the species *Diamantinasaurus matildae*, was excavated near Winton in Queensland, Australia, in May 2017.

Judy's remains had been disturbed by scavengers shortly after death, sometime between 94 million and 101 million years ago, but large parts of the dinosaur's body were intact, including mineralised sections of its skin. Most remarkably, its gut contents were preserved, containing an array of vegetation.

Until now, it was assumed from the skulls and jaws of sauropods that they were vegetarians, but palaeontologists had no direct evidence of what was in their diet.

"It's hard not to view Judy with a sense of awe that you maybe don't get with other sauropods," says Stephen Poropat at Curtin University in Perth, Australia, part of the team that excavated and analysed the fossil.

Measuring around 11 metres long, with a 4-metre neck and a 3.3-metre tail, Judy was probably not yet fully grown when she died. Her skin and gut contents went on display at the Australian Age of Dinosaurs Museum in Winton on 9 June.

"You can really get a sense of Judy's overall size and the shape of the whole animal, which is something that just hasn't been possible with previous sauropod fossils in Australia because none of them are anywhere near as complete as Judy is," says Poropat.

The dinosaur's belly was "chock-full" of vegetation, he says. "The plants were all inside the skin and within the body cavity and we were confident we had the possible gut contents of this animal. We knew we possibly had a world-first."

Among this material, the team identified leaves and fruiting bodies from conifers including *Araucaria* and *Austrosequoia wintonensis*, as well as leaves from unidentified flowering plants. While the vegetation appeared sheared, it was unchewed and of such a wide range that the team members think Judy was an indiscriminate bulk feeder (*Current Biology*, DOI: 10.1016/j.cub.2025.04.053).

The skeleton of Judy was excavated in Queensland, Australia

AUSTRALIAN AGE OF DINOSAURS MUSEUM; STEPHEN POROPAT

"There's no mastication happening in the mouth at all. It's just simple snip and swallow"

"There's no mastication happening in the mouth at all," says Poropat. "It's just simple snip and swallow."

With such a vast array of unchewed vegetation in Judy's abdominal cavity, it is likely that sauropods would have emitted large amounts of methane, as elephants and rhinos do, he adds.

"It's always nice to find actual evidence of what extinct creatures, like gigantic dinosaurs, were eating," says John Long at Flinders University in Adelaide, Australia, who wasn't involved in the study. "If we only had skulls of panda bears, we would assume they ate what other bears ate – not just bamboo."

"Up until now, we have only speculated that these giants ate plants. Now we know, not only did they eat plants, but ate a variety of species from both the ground and from the branches of trees," says Long.

Psychology

Why do we follow rules?

The discovery that around a quarter of people will follow rules unconditionally could have implications for how we create laws, finds **Helen Thomson**

WOULD you follow a rule, even if doing so harms you and no one would know if you broke it? A series of experiments suggests that 1 in 4 people do exactly that: obey rules even in the absence of social pressure, punishment and personal gain. The results challenge traditional economic theories, which assume that rule- following is driven largely by extrinsic incentives, and could reshape how we design new laws.

"Following or breaking rules is what human social behaviour often amounts to," says Simon Gaechter at the University of Nottingham, UK, but researchers disagree on why we do so. "Economists tend to emphasise extrinsic incentives, and other social scientists stress the importance of conformity."

Motivated to create some unity, Gaechter and his colleagues created a variety of simple computer tasks in which more than 14,000 people were told to move a circle to a red traffic light, wait until it turned green, and then reach a finish line as quickly as possible to maximise their reward.

In each test, participants started with $20, but the reward fell by $1 per second, so breaking the rules by not waiting for the green light would mean more money. Yet despite participants being told their actions were anonymous and no one would be watching what they did, around 70 per cent of people still followed the rule, waiting for the traffic light to turn green before proceeding.

Even when the researchers pointed out the potential gain from breaking the rule, the majority of people still complied. "There was no social pressure, it was anonymous, there was absolutely no reason to follow the rule. Nevertheless, almost 60 per cent of people followed it," says Gaechter.

To explore the influence of social expectations on rule-following, the team asked participants about whether they thought others would or should obey the rule. Those who thought others would comply were more likely to follow the rule themselves, showing that even when alone, people form internal beliefs about what is socially acceptable and adjust their actions accordingly.

"When you're designing laws, it's not just a simple cost versus benefit calculation"

The study reinforces the fact that perceived social expectations influence our behaviour, says Pieter Desmet at Erasmus University Rotterdam in the Netherlands – an idea that has been exploited by "nudge units" in governments. "Simply adding '9 out of 10 people pay their taxes on time' to a reminder letter can significantly speed up tax compliance. It powers some of the most effective policy nudges," he says.

However, this social expectation didn't affect everyone: around 25 per cent of people followed the rule regardless of what they thought others would do or think, while also knowing that breaking the rule would hurt no one apart from themselves, by resulting in a smaller reward. This was the most important finding, says Gaechter. "That's showing an intrinsic respect for rules. You give these people a rule and they follow it unconditionally."

"A surprisingly large number of people will follow rules even when those rules are arbitrary, costly to follow, unenforced and not widely followed by others," says Desmet. Still, he cautions that this finding may not straightforwardly translate to the real world – other studies show the more demanding a rule, the less likely it is to be followed, for instance.

In another part of the experiment, those taking part observed how other participants behaved. Seeing others following the rule didn't significantly alter their behaviour. However, observing others violate the rule made a modest impression, nudging a small number to do the same (*Nature Human Behaviour*, doi.org/g9m6h4).

MEIZHI LANG/UNSPLASH

Would you follow the rule and wait in line, or are you a queue jumper?

Social expectations

Further variations of Gaechter's experiment introduced extrinsic penalties, for instance, stating that rule-breaking would be caught 90 per cent of the time, leading to no reward at all. This change increased compliance to about 78 per cent.

Taken together, the results suggest that while extrinsic rewards increase conformity, a substantial part of compliance stems from social expectations, and, for many people, an internalised commitment to following rules.

Gaechter says that economists have historically focused on incentivising rules as a primary driver of promoting compliance. But he argues that this overlooks the fact that many follow rules simply because they believe rules are there to be followed.

Depending on the context, that intrinsic motivation could be beneficial or could perpetuate harmful actions. "It shows that when you're designing laws, it's not just a simple cost versus benefit calculation; it's more interesting than that," says Gaechter.

Desmet thinks that there are clear implications for policy-makers, as the experiments show that even unenforced or largely symbolic rules have a powerful impact on behaviour. "Law speaks to society, influencing conduct not just through the threat of punishment, but by expressing shared norms and expectations."

Archaeology

Dead Sea Scrolls analysis may force rethink of ancient Jewish history

Christa Lesté-Lasserre

SOME of the Dead Sea Scrolls may be up to a century older than previously thought.

This new assessment, based on AI analysis of handwriting and modern radiocarbon dating techniques, even suggests that a few scrolls – like those containing the biblical books Daniel and Ecclesiastes – may be copies made during the lifetimes of the books' original authors, says Mladen Popović at the University of Groningen in the Netherlands.

"I'm not saying they were written by the authors," he says. "But our study is a significant first step in rethinking what we know about literacy in ancient Judea, which now seems to have emerged before its political independence from the empires fighting to control it."

The scrolls were discovered by shepherds in a cave on the north-west shore of the Dead Sea in 1947. Nearly 1000 fragmented manuscripts have since been found in 11 caves and other sites nearby. These Dead Sea Scrolls include the oldest known copies of some Old Testament books.

Scholars believed the scrolls were hidden to protect them from the Romans, who destroyed the Jewish temple in Jerusalem in AD 70. Judging by the letterforms in the texts – mostly written in Hebrew or Aramaic – they were thought to date from as early as 150 BC. This was based on comparisons with hand-dated administrative manuscripts from other sites from the 5th and 4th centuries BC and from the 1st and 2nd centuries AD, but nothing specific to the scrolls' time period.

The texts known as the Dead Sea Scrolls may be older than thought

This view changed in the 1990s, when radiocarbon dating of a few dozen scroll fragments suggested a wider age range of about 500 years, starting in the 3rd century BC – to the surprise and scepticism of handwriting scholars.

Now, Popović and his team have taken a new approach. They first radiocarbon-dated 27 manuscripts from the Dead Sea Scrolls, representing a range of different writing styles. They then trained an AI system to associate handwriting styles with specific dates from 24 of the tested scrolls.

Finally, to see how well the AI had learned, the researchers used it to date the three remaining manuscripts and found that its responses aligned with the carbon dating, and it was able to estimate dates to within about 30 years.

The team then used the AI to analyse 135 of the scrolls and found that many were older than previously believed (*PLoS One*, doi.org/g9m75q). One early script style, known as Hasmonaean, may have begun around 200 BC, a century earlier than scholars had thought. The later Herodian style also appears to date back 80 years earlier than expected. That means the two probably overlapped for several decades.

"The story that scholars tell about the history of this community depends in part upon the chronology of the scrolls," says Brent Nongbri at MF Norwegian School of Theology, Religion and Society in Oslo. "So, some aspects of this story will probably need to be revisited." ▮

SCIENCE HISTORY IMAGES/ALAMY

Health

Massaging the neck and face could help flush out brain waste

A DEVICE that massages the face and neck boosts the brain's waste disposal system in mice. The hope is that something similar could one day be used to reduce the severity of conditions like Alzheimer's disease.

Cerebrospinal fluid (CSF) bathes our brain before exiting into a network of thin tubes called lymphatic vessels. Studies in mice have shown that this fluid flushes out waste products made by brain cells, including beta-amyloid, a protein linked to conditions such as Alzheimer's and Parkinson's.

This has spurred scientists to wonder whether enhancing CSF flow could boost brain health. But lymphatic vessels that drain CSF had only been seen deep in the neck, making them hard to manipulate, says Gou Young Koh at the Korea Advanced Institute of Science and Technology in South Korea.

Now, Koh and his team have found lymphatic vessels around 5 millimetres below the skin on the face and neck of mice and monkeys, after injecting the animals with a fluorescent dye that labels CSF and imaging them under anaesthesia.

To see whether massaging these vessels could boost CSF flow, the researchers attached a small rod to a 1-centimetre-wide cotton ball. They used it to stroke downwards along the face and neck of older mice, aged around 2 years, and younger mice that were a few months old, for a minute.

Up to half an hour later, the CSF flowed around three times faster through the mice's brains, on average. The procedure also seemed to reverse age-related declines in CSF flow (*Nature*, doi.org/g9m67q).

"Stroking mice's faces with a cotton ball led to their brains' cerebrospinal fluid flowing three times faster"

In unpublished work, the team found similar results in monkeys and have pinpointed lymphatic vessels under the skin of human cadavers, suggesting massaging could also work in people, says Koh.

But mice and monkeys have some anatomical differences to humans, so further work is needed to establish this, says Vesa Kiviniemi at the University of Oulu in Finland. ▮

Carissa Wong

Mathematics

Could computers run on gravity?

A way to identify when information has been changed by manipulating space-time could lay the foundation for a new type of computer, finds **Karmela Padavic-Callaghan**

A MATHEMATICAL test for the nature of space-time – the fabric of physical reality – may be the first step towards novel computer-like devices that process information using gravity.

Is space-time an unchanging expanse, or can it be warped in ways that affect a signal travelling through it? According to Albert Einstein's theory of special relativity, it is static – but his theory of general relativity reveals something completely different. In this framework, massive objects make space-time dimple and curve, like when a ball is dropped onto a taut sheet, which could change the path of a signal moving nearby.

Eleftherios-Ermis Tselentis at the Brussels Polytechnic School in Belgium and Ämin Baumeler at the University of Lugano in Switzerland have now developed a mathematical test for whether space-time in any given region is unchanging or not.

They analysed a scenario in which three or more people exchange information by messaging each other. They asked whether it is possible to tell if one of the people – nicknamed Alice, Bob and Charlie – could change the way that information travels by warping space-time. Could Alice receive a message meant for Bob because the region of space-time that the signal travelled through got distorted? Could she reverse causality for Charlie and Bob – so that Bob might receive a response from Charlie before even messaging him – by messing with space-time near her?

Tselentis and Baumeler derived an equation that could help Alice, Bob and Charlie know when these situations are possible. After several rounds of sending messages, they could tally up who got what message when, and then plug that data into the equation.

MARIAN/GETTY IMAGES

Curving space-time could change the way information travels

The result would reveal whether they had been communicating in a setting where manipulating space-time was an option (*Physical Review A*, doi.org/pqrz). This framework was general enough that the trio wouldn't have to know anything about where in space they are or use any non-standard messaging devices.

Baumeler says that general relativity was understood as a successful description of our physical reality for decades, but we still lacked a rigorous mathematical connection between changing space-time and the flow of information. Understanding information flow, and related concepts, forms the foundations of computer science.

In this sense, he says, his team's work, while purely theoretical, may be a very early step towards using gravitational effects – moving masses around and distorting space-time – for computation.

"If we are going to use the mysteries of physics to do computing, why not try general relativity?" says Pablo Arrighi at Paris-Saclay University in France. He says that other researchers have considered extreme ideas, like throwing a computer into a black hole so the warping of space-time near the edge of the black hole causes time to slow down and enables otherwise impossibly long calculations to conclude.

"If we are going to use the mysteries of physics to do computing, why not try general relativity?"

But the new theory stands out because it doesn't focus on any special devices or theories of space, which means it could be applied to a broad range of situations, says Arrighi. Building a "gravity information" device, however, currently seems impractical, he says.

Tselentis and Baumeler also say that much more work is needed before they can design a practical device. The calculations in their recent work rely on fantastical situations – picture Alice moving a whole planet to sit between Charlie and Bob, for example. For their ideas to find practical use, they need to better understand the effects of gravity at much smaller scales.

A strange turn of events

Gravity produces notoriously weak signals for objects that aren't extremely massive, which is why you never feel the effect of space-time warping around a pencil on your desk. Still, some devices, such as clocks made from extremely cold atoms, can detect these effects. Future development of such devices – combined with advances in theories connecting gravity and information – could lead to more practical applications of Tselentis and Baumeler's work.

Their research could illuminate the connections between the ways that different paradigms – information theory and special relativity – deal with causality, says V. Vilasini at the University of Grenoble Alpes in France. Because the new work engages with ideas like inverting the order of events, it raises questions such as what an event actually is, she says.

In her view, the next step is to more fully integrate their approach with the theory of general relativity, which would allow for further investigations of space-time's nature.

"Could astrophysical phenomena like black hole mergers, which produce gravitational waves that reach Earth, hold physically meaningful signatures of the type of correlations studied in this work, and could this allow us to study how they warp space-time?" she asks. ▮

Animal behaviour

Worms make tentacle-like towers to move around

WHAT do you do when food is running low and you are a tiny, millimetre-long worm? The answer, it turns out, is join up with thousands of your fellows to make a tentacle-like superorganism.

Biologists studying nematode worms in labs have long known that they occasionally form "towers", but these haven't been studied in detail, says Serena Ding at the Max Planck Institute of Animal Behavior in Germany. So, she and her colleagues have done just that.

They found that worms such as *Caenorhabditis elegans* are most likely to form towers when there are large numbers of them, a shortage of food and a structure for them to congregate on – in these experiments, a toothbrush bristle.

The worms did sometimes form towers in the absence of any physical support, but these were no higher than 5 millimetres and lasted for just a minute. With a bristle as a foundation, the towers reached 11 mm and lasted up to half a day (*Current Biology*, doi.org/g9nb29). There are reports of other worms forming towers 50 mm high. "They can grow super big," says Ding.

While the base of a tower is stationary, the other end can extend to nearby surfaces and form a bridge. The towers can also grab hold of objects that touch them, such as the legs of fruit flies, resulting in part or all of each tower being picked up. In this way, the worms might get a free ride to other places.

It is known that individual nematode worms hitch rides on insects, but it hadn't been shown that entire towers can do it. "That's the presumed function that we could confirm," says Ding.

With the help of digital microscopes, the team also recorded towers on rotting apples in an orchard near the institute – the first time the behaviour has been observed in the wild. ▮ **MLP**

Analysis Health

Is ADHD on the rise? No – but that's not the whole story

There is no evidence of an increase among children, but there are big differences between countries, finds **Michael Le Page**

DESPITE reports of a recent surge in ADHD among children, an assessment of thousands of studies released since 2020 suggests, surprisingly, that there hasn't been. But the researchers behind the work have expressed their frustration at the poor quality of data available.

"The best data we have suggests that there has been no meaningful increase in ADHD prevalence," says Alex Martin at King's College London, but that masks a larger problem, she says. "Most of the research is too biased to draw conclusions from."

While there may have been no rise since 2020, the data shows there are still big differences between countries in terms of the proportion of children being diagnosed with ADHD.

The team's initial search for recent studies on the prevalence of ADHD produced more than 9000 results. "We read every single one," says Martin. But only 40 studies included original data from after 2020 that was based on formal diagnoses or surveys that could be included in the analysis. And of these, only four were high-quality studies that avoided serious biases, for instance, through diagnoses being made by qualified clinicians.

Two of the four were from the US, one was from Canada and one was from Sweden. Each looked at diagnoses over a number of years.

10%

The percentage of children diagnosed with ADHD in the US

3%

The percentage of children diagnosed with ADHD in Sweden

For example, one of the US studies looked at data from 2017 to 2022. According to these studies, in the US, around 10 per cent of children have been diagnosed with ADHD, compared with 8 per cent in Canada and 3 per cent in Sweden (*Journal of Affective Disorders*, doi.org/pqrf).

The finding of no increase is surprising because there has been much more awareness of ADHD in recent years and reports of many more people seeking diagnoses and help with the condition.

There have been reports of a rise in ADHD among children

IMGORTHAND/GETTY IMAGES

"It seems that our best evidence suggests that the true rate of ADHD probably isn't increasing that much," says Philip Shaw, also at King's College London but not part of Martin's team.

But he says that, in the UK, the number of diagnoses in both children and adults definitely increased between 2000 and 2018, and he thinks it is likely it has continued to rise.

Shaw thinks this is because health services are "playing catch-up". For instance, in 2018, it was estimated that 5 per cent of all people in the UK had ADHD, but the highest proportion of formal diagnoses in any group was just 3.5 per cent in boys aged between 10 and 16.

"There's both an increased recognition and – very welcome – less stigma around ADHD, which means that people are increasingly coming forward for assessment," he says. "And while we're working through that backlog, there are simply going to be long waiting lists."

"The history of ADHD, in the UK at least, is one of chronic under-recognition, especially for certain demographic groups, in particular for girls and women," says Edmund Sonuga-Barke, also at King's College London but not part of Martin's team. "So, part of the increase in diagnosis we've seen over the last 10 or so years is really a resetting or recalibration or a catch-up."

"It's hard to draw conclusions about increased attention surrounding ADHD," says Martin. "So, as well as there being very unreliable recent data, some of the data that is being published recently is actually very much out of date and we have to be really cautious when we are reporting prevalence estimates and checking where that data is coming from." ▮

Neuroscience

How our brains sort imagination from reality

Carissa Wong

HOW do you tell if something is real or imaginary? We have now discovered a brain pathway that seems to help you decide – and the finding could improve treatments for hallucinations caused by conditions such as Parkinson's disease.

We already knew that the parts of the brain that activate when we imagine something visual are similar to those involved in perceiving actual visual stimuli, but it is unclear how we distinguish between the two.

"How does our brain know which of these signals reflect our imagination or what is reality?" says Nadine Dijkstra at University College London.

To find out, Dijkstra and her colleagues asked 26 people to carry out a visual task while their brain activity was recorded via MRI scans. The participants had to view a static grey block on a screen for 2 seconds, in a process repeated more than 100 times.

They were also instructed to imagine seeing diagonal lines on each block, though half of the blocks really did have diagonal lines.

"This could deepen our understanding of how to treat visual hallucinations caused by Parkinson's."

After viewing each block, the participants were asked to rate how vividly they saw the lines on a scale of 1 to 4 and say whether they thought the lines were real or imaginary.

By analysing the brain recordings, the researchers found that an area called the fusiform gyrus was more active when people saw lines more vividly, regardless of whether the lines were truly there.

MARIAM SOLIMAN/UNSPLASH

When you imagine, you activate certain parts of your brain

"We know from previous studies that this area activates during perception and imagination, but now we showed that this actually tracks how vividly you experience visual imagery," says Dijkstra.

Crucially, when the activity in the fusiform gyrus rose above a certain threshold, this led to a jump in activity in an area called the anterior insula, leading people to judge something as real (*Neuron*, doi.org/g9ncmg).

"You've got this other region that's connecting with the fusiform gyrus – perhaps it's getting signals and giving signals back – and it's making a more binary decision: real or not real," says Dijkstra.

While it is unlikely that these brain regions are the only ones involved in deciding what is real versus imaginary, further exploration of this pathway could deepen our understanding of how to treat visual hallucinations caused by conditions such as schizophrenia and Parkinson's disease.

"Perhaps in people who experience visual hallucinations, either there's too strong activity in the fusiform gyrus when they're imagining or their anterior insula is not monitoring signals correctly," says Dijkstra.

"I think this work is going to be informative about clinical cases," says Adam Zeman at the University of Exeter, UK.

"But there's quite a big step between deciding whether some small fluctuation in your sensory experience is due to something happening in the real world and seeing a fully formed hallucination – which you remain for some time convinced of," he says.

To help bridge this gap, Dijkstra's team is now exploring the pathway in people with Parkinson's disease. ▮

Health

Retinal implant helps blind mice see again

PEOPLE with conditions such as age-related macular degeneration could one day benefit from a retinal implant that has partly restored vision in blind mice.

Shuiyuan Wang at Fudan University in China and his colleagues designed a retinal prosthesis made of metallic nanoparticles that can take over the function of lost retinal cells, turning light into electrical signals that can be transmitted to the brain through nerves.

To test the prosthesis, the team injected the particles into the retinas of mice that had been genetically engineered to develop near-complete blindness.

The researchers restricted the animals' access to water for three days, doing the same for mice with typical vision and blind mice without the prosthesis. Next, they trained all the mice to touch a 6-centimetre-wide circle on a screen if they wanted water.

After training, each mouse completed 40 test trials. Mice with complete vision were successful at pressing the button 78 per cent of the time. Those with implants succeeded 68 per cent of the time, while untreated blind mice managed it 27 per cent of the time (*Science*, doi.org/pqq9). "It's a very clear effect," says Patrick Degenaar at Newcastle University, UK.

Two months later, the researchers found minimal signs of toxicity in the eyes of mice with the implants – but longer-term safety data is needed, says Degenaar.

"People with age-related macular degeneration and retinitis pigmentosa could benefit from [the prosthetic]," says Leslie Askew at the University of Surrey, UK.

However, Degenaar says people with age-related macular degeneration usually have a level of sight that wouldn't be worth risking by implanting the prosthetic. ▮ CW

Human evolution

Tools helped language evolve

Advances in technology and cultural practices led our ancestors to develop new ways of explaining concepts to others, finds **Michael Marshall**

AN ANALYSIS of more than 3 million years of human evolution shows that communication and technology developed in lockstep. As tools progressed, so too did our teaching skills, in order to pass these newfound abilities on to the next generation.

"We have a scenario for the evolution of the mode of cultural transmission in human evolution," says Francesco d'Errico at the University of Bordeaux in France.

One distinctive feature of humans is that we have developed increasingly complex tools and behaviours. For instance, ancient humans created sharp stones that could be used for stabbing and cutting, then attached them to wooden sticks to create spears – a technique known as hafting.

Crucially, we can tell others how to perform these behaviours. But in the distant past we weren't as good at passing on information – especially before complex language arose.

With Ivan Colagè at the Pontifical University of the Holy Cross in Rome, Italy, d'Errico set out to track how our ability to transmit cultural information has developed over the past 3.3 million years, alongside changing behaviours and technologies. They tracked 103 cultural traits, including specific types of stone tools, ornaments such as beads, pigments and mortuary practices like burials. They identified when each first appeared regularly in the archaeological record, suggesting it had become common practice.

Humans had to learn how to use tools like these harpoons

JAVIER TRUEBA/MSF/SCIENCE PHOTO LIBRARY

The pair also assessed how hard each trait was to pick up by looking at three aspects of learning. First, spatial: can you learn the skill by watching from a distance, or do you need to be close enough to touch? Second, temporal: is one lesson enough, or do you need multiple sessions, focusing on different steps? And third, social: who learns from whom? The pair assessed all the traits themselves and also asked a panel of 24 experts for their assessments.

The work suggests there were two major shifts in cultural transmission. First, around 600,000 years ago, ancient humans were overtly teaching each other, although not necessarily using spoken instructions; gestures may have been enough. That is well before the origin of our species, *Homo sapiens*, and coincides with the emergence of hafting.

Then, between 200,000 and 100,000 years ago, humans developed modern language (*PLoS One*, doi.org/pqq7). This was necessary because they were performing behaviours like burials. "This involves many different steps, and also you have to explain why you do that," says d'Errico.

"The link between cultural transmission and cultural complexity is robust," says Ceri Shipton at University College London. He adds that, while there is much uncertainty about when humans developed language, the new estimate is "a reasonable timeframe". ▮

Entomology

Highly destructive termite hybrids may pose global threat

FLORIDA'S newest termite is two for the price of one, but nobody's celebrating. Two species of globally invasive, timber-chewing insects are interbreeding there, creating hybrid colonies that could produce incredibly hardy termites that threaten buildings and forests alike.

As of 2010, termite pests were responsible for about $40 billion in damages globally every year, with around 80 per cent of that cost coming from subterranean termites like *Coptotermes*. The Formosan subterranean termite (*Coptotermes formosanus*) has invaded much of the northern hemisphere's warm temperate zones. The related Asian subterranean termite (*Coptotermes gestroi*) has spread from South-East Asia throughout the world's tropics. The two species have overlapped in southern Florida since the late 1990s, says Thomas Chouvenc at the University of Florida.

In 2015, Chouvenc and his colleagues showed that the two species could successfully produce hybrid offspring in the lab. In 2021, in Fort Lauderdale, Florida, Chouvenc found alates – winged termites that leave the nest to mate and start new nests – whose appearance was between the Formosan and smaller, darker Asian species. Genetic analyses confirmed them as hybrids. The team also discovered a hybrid nest in a local park next to a marina.

SHUTTERSTOCK/JOAN OLSEN

Formosan subterranean termites (*Coptotermes formosanus*) are a highly destructive species

In 2024, wild hybrids were confirmed by researchers in Taiwan, where the two species have overlapped for a century. The termites are now interbreeding in southern Florida (*Proceedings of the Royal Society B*, doi.org/pqq5).

The researchers also found that first-generation hybrid females could mate and form colonies with the males of either parental species. The termites' location near busy ports increases the likelihood of such hybrids spreading globally.

"[Humans] allowed these termites to spread because we were not really paying attention," says Chouvenc. "Now we are kind of paying the price for it." ▮

Jake Buehler

Space

We may have discovered the first-ever stars powered by dark matter

Alex Wilkins

ASTRONOMERS have found the strongest evidence yet for the existence of dark stars, a type of enormous star in the early universe partially powered by dark matter – but not everyone is convinced.

The idea of a dark star was first floated in 2007 by Katherine Freese at the University of Texas at Austin and her colleagues. They suggested that vast clouds of hydrogen and helium in the early universe could have mixed with a self-annihilating form of dark matter to create massive, stable stars. Without dark matter, such large clouds of gas would collapse to form a black hole, but the energy from the self-annihilating dark matter can prevent this, allowing the gas to heat up and produce a star-like object, even though the nuclear fusion that takes place in most ordinary stars is absent.

There was scant evidence for these exotic objects until 2022, when the James Webb Space Telescope (JWST) began spotting an unusually high number of very bright, distant objects from just a few million years after the big bang, which astronomers thought were likely to be galaxies. Freese and her team showed that three of these galaxies also matched several properties from dark star simulations, but they lacked detailed spectroscopic data to make a conclusive discovery.

"If it's real, then I don't know how else you'd explain it other than with a dark star"

Now, Freese and her colleagues say that new spectroscopic observations of these early galaxies from JWST lines up well with theoretical predictions for how dark stars should look, as well as identifying another two dark star candidates (arXiv, doi.org/pqrg).

One of these newer candidates also contains a tantalising hint of a specific kind of helium – missing an electron – that, if confirmed, would be a unique identifier of dark stars. "If it's real, then I don't know how else you'd explain it other than with a dark star," says Freese. However, the evidence for this is limited so far, she says.

But Daniel Whalen at the University of Portsmouth, UK, argues that supermassive primordial stars, a dark matter-free alternative explanation for giant, early stars, match the JWST data equally well. "They ignore an entire body of literature on the formation of supermassive primordial stars, some of which could give signatures very similar to the signatures that they show," says Whalen.

Freese disagrees, saying that the only plausible route to make such massive stars is for them to be burning dark matter.

One potential wrinkle is that separate observations of the objects studied by Freese and her colleagues, from the Atacama Large Millimeter Array in Chile, indicate the presence of oxygen. As this element wouldn't be found in dark stars, it suggests that these dark stars are mixed in with other stars or companions, says Freese. But Whalen sees the oxygen as a clear sign that these objects can't be dark stars, as their formation would have been disrupted by regular stars exploding in supernovae. ▮

Climate change

There could be a surprising upside to losing coral reefs

THE decline of coral reefs could mean oceans can absorb more carbon dioxide, slowing the build up of this greenhouse gas in the atmosphere.

"It is a beneficial effect if you only care about the concentration of CO_2 in the atmosphere," says Lester Kwiatkowski at Sorbonne University in Paris, France. But the decline will reduce biodiversity and leave coasts exposed to rising seas, he says.

How much the world will warm depends mainly on the level of CO_2 in the atmosphere. So far, the land and oceans have been soaking up around half of the extra CO_2 we have emitted. Any factors that increase or decrease these so-called land or ocean carbon sinks could therefore have a significant impact.

REINHARD DIRSCHERL/ALAMY

Rising seawater temperatures are causing mass coral bleaching

It is often assumed that corals remove CO_2 from seawater as they grow their calcium carbonate skeletons. In fact, the process, called calcification, is a net source of CO_2.

Observations suggest coral reef calcification is declining as rising seawater temperatures cause mass coral bleaching and die-offs. The higher level of CO_2 is also making oceans more acidic, which can make it harder to build carbonate skeletons and even lead to their dissolution.

Kwiatkowski and his team took published estimates of how corals will be affected by warming and ocean acidification and used a computer model to work out how this might change the ocean sink in various emission scenarios. They conclude that the oceans could take up between 1 and 5 per cent more carbon by 2100, and up to 13 per cent more by 2300 (*PNAS*, doi.org/pqms).

But the work assumes that corals aren't able to adapt or acclimatise, says Chris Jury at the University of Hawai'i at Manoa.

If Kwiatkowski's team is correct, the amount of emitted CO_2 that will lead to a given level of warming – the carbon budget – is a little larger than currently thought.

"I think we would like our budgets to be as accurate as possible, even if we're blowing through them," says Kwiatkowski. ▮

Michael Le Page

Quantum computers take on physics

Computer simulations are pushing the boundaries of what we can learn about interactions that happen inside particle colliders, finds **Karmela Padavic-Callaghan**

SOME of the most fundamental forces in the universe – and some of the trickiest to understand – can now be studied using quantum computers. Two experiments have used them to pave a new way forwards for nuclear and particle physics.

"We have this sort of grand scheme where we eventually want to do quantum computing for high-energy physics," says Torsten Zache at the University of Innsbruck in Austria. "There's a strong consensus that large-scale quantum computers will actually be able to solve problems that are otherwise intractable."

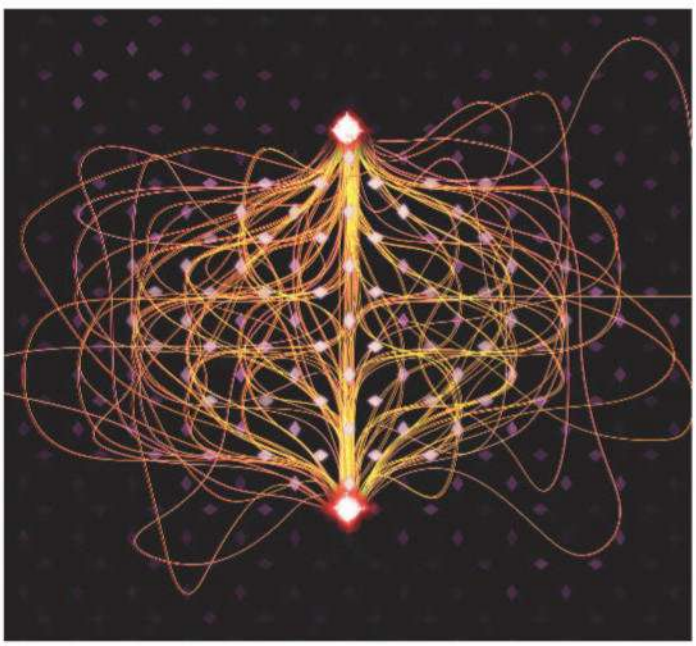
He and his colleagues used a quantum computer to simulate how excited particles – those with lots of energy – behave in quantum fields, a situation akin to the conditions they experience in particle accelerators (*Nature*, doi.org/pqmp).

Pedram Roushan at Google and his colleagues ran a similar simulation on a different quantum computer (*Nature*, doi.org/pqmq).

While conventional computers can typically capture only snapshots of particle behaviour, the new simulations show how they behave over time, a bit like making a movie.

Roushan says it all starts with quantum fields, which extend through space and exert forces on particles. His team wanted to simulate the electromagnetic field, but there was an added challenge of ensuring that the simulated field didn't just apply everywhere, but that it also correctly affects particles when zooming in on just a few.

Roushan's and Zache's teams each simulated a version of this local structure based on a simplification of the standard model of particle physics – our best theory for how all particles and the forces acting upon them behave.



GOOGLE QUANTUM AI, DESIGNED BY SAYO STUDIO

Quantum computers can simulate the connections between high-energy particles

Zache and his colleagues used a quantum computer made from extremely cold atoms controlled by lasers and electromagnetic pulses, which was produced by the quantum computing firm QuEra. Roushan's team worked with Google's Sycamore quantum computer, which uses tiny superconducting circuits.

Both teams simulated two particles in the quantum field that were first confined to move in concert, and then broke away from each other. In that scenario, particles behave as if connected by a string of energy that vibrates and eventually snaps. Within the standard model, this string breaking is important for quarks, which make up the nuclei of atoms and are held together by the strong force. It is also key to matter and antimatter particle pairs.

While conventional computers can accurately simulate this phenomenon at one instance in time, or when energies are relatively low, they can only capture the whole process for very small systems. "For decades, we have been paying attention to static physics, but what if you want a dynamical situation? We visualised it for the first time," says Roushan.

"Large-scale quantum computers will be able to solve problems that are otherwise intractable"

What they saw doesn't contradict the standard model and is in line with state-of-the-art conventional computer simulations, but using only a slightly bigger quantum computer would push this work into unknown territory, says Jad Halimeh at the University of Munich in Germany. He says the new experiments bring quantum computers "neck and neck" with the best traditional computers.

Anthony Ciavarella at the Lawrence Berkeley National Laboratory in California says string-breaking for quarks is where there are the most open theoretical questions, and, just a few years ago, researchers could barely use quantum computing hardware to simulate the process.

One step beyond

But now, says Halimeh, quantum computers are slated to be "the major player" in understanding what happens in the hearts of particle colliders.

When very energetic ions get smashed together in a collider, they produce showers of particles that hit detectors – the data is like the last few frames of a movie, and physicists can use it to reverse engineer what happened in the frames before. But quantum computers could let us start with the collision and understand what happens next, he says.

To get there, researchers will have to run their simulations on larger quantum computers and in three spatial dimensions instead of two. Roushan says his team is working with the realities and limitations of some of the best existing quantum computers, and that there isn't one magic trick that can fast-track their simulations – both the hardware and the way in which simulations are programmed must keep improving.

But for now, he says, simulations like these can also help researchers understand less extreme particle physics, such as the ways excited particles behave in exotic quantum materials. ▮

Environment

Rivers are leaking ancient carbon into the atmosphere

Madeleine Cuff

OXYGEN/GETTY IMAGES

The Katun river, in Russia, could be a source of emissions

CARBON stored millenia ago is being released by rivers worldwide, in a finding that has taken scientists by surprise and suggests human activities are damaging the natural landscape more than previously thought.

Researchers already knew rivers released carbon dioxide and methane as part of the global carbon cycle – the short-term movement of gases that happens as living things grow and decompose. They are thought to emit around 2 gigatonnes of this carbon each year.

But when Josh Dean at the University of Bristol, UK, and his colleagues set out to determine how old this carbon really is, they found that around 60 per cent of global river emissions are from thousands-of-years-old stores (*Nature*, doi.org/pqg3).

The team used radiocarbon dating to assess the age of carbon and methane released from more than 700 river segments across 26 countries.

"What really surprised us, when we compiled all the data that we could get, was that [more than half of the carbon being released] could be coming from these much, much older carbon stores," says Dean. "There's a sort of continuous leak, or sideways flow, of these older carbon stores."

60%

The proportion of millenia-old carbon in global river emissions

Ancient carbon is trapped in rocks, peat bogs and wetlands. The findings suggest that as much as 1 gigatonne of it is being released back into the atmosphere each year through rivers. That means plants and soils are probably removing around 1 gigatonne more CO_2 from the atmosphere each year than first thought, to counteract this impact.

"This is the first global synthesis of how old CO_2 emissions from rivers are, which is pretty cool," says Taylor Maavara at the Cary Institute of Ecosystem Studies in Millbrook, New York.

The pressing question now is why rivers are releasing so much ancient carbon. It could be due to climate change and other human activities disrupting the natural landscape, says Dean, pointing out that the carbon being released by rivers seems to have been "getting older" since the 1990s.

"There is a possibility that we're disturbing these long-term carbon stores, and so, as a result, we're seeing more old carbon coming out through this pathway," he says.

For example, rising temperatures caused by climate change could be triggering the release of carbon from thawing permafrost, or accelerating the rate of rock weathering. Other activities, such as the draining of peatlands or drying out of wetlands, could also be contributing. Dean stresses that more work is needed to determine the extent to which human activity is driving this process, and how the release of carbon is changing over time.

The findings will have implications for how nations draw up their climate plans, by determining how much they rely on the natural landscape to remove ongoing CO_2 emissions.

"This work raises interesting questions about how and to what degree that ancient carbon can be managed," says Scott Tiegs at Oakland University in Rochester Hills, Michigan, adding that minimising climate change is likely to be important for preventing the release of CO_2 and methane from ancient stores. ▮

Health

Infant antibody treatment may best protect against RSV

Grace Wade

AN ANTIBODY treatment for respiratory syncytial virus (RSV) may be more effective at protecting infants from severe illness than vaccination during pregnancy.

About 100,000 children under the age of 5 die from RSV each year. There are two ways to immunise infants against the virus. The first is a vaccine given during pregnancy, which passes antibodies to the fetus and protects babies for the first six months of life. The second is a one-time antibody injection, called Beyfortus, administered to infants shortly before their first RSV season or within one week after birth.

To investigate each approach, Oliver Martyn at the pharmaceutical company Sanofi and his colleagues analysed RSV hospitalisation rates in the UK and Spain among infants 1 year old and younger between June 2022 and May 2025. Sanofi makes Beyfortus with the company AstraZeneca.

During the 2024 to 2025 RSV season, the UK offered only the maternal RSV vaccine. Meanwhile, Spain offered only Beyfortus through its public healthcare system; the maternal RSV vaccine could be purchased privately.

Hospitalisations fell 69 per cent in Spain during the 2024 to 2025 season compared with 2022 to 2023, when neither immunisations were available. Rates fell almost 27 per cent in the UK. The finding, presented by Martyn at a 29 May meeting of the European Society for Paediatric Infectious Diseases in Romania, suggests antibody treatment better protects infants from severe RSV than maternal vaccination.

However, the study included infants whose mothers were ineligible for maternal vaccination in the UK "and thus underestimated the impact" of it, says a spokesperson for Pfizer, the firm that developed the maternal vaccine. ▮

Space

The moon may be full of platinum

Mining on the moon could be technically easier than on asteroids, but more legally challenging

James Woodford

OVER a trillion dollars' worth of platinum and other precious metals could be held inside craters on the moon, deposited there by asteroids.

Jayanth Chennamangalam, an independent researcher in Vancouver, Canada, and his colleagues looked at whether there may be commercial quantities of platinum group metals (platinum, palladium, rhodium, ruthenium, iridium and osmium) that were left behind by asteroids hitting the lunar surface.

The team modelled the fraction of lunar craters thought to have been created by metallic asteroids, the number of these asteroids that had a sufficient concentration of platinum group metals, and how many would have crashed on the moon with a velocity small enough to leave significant remnants behind. They found that out of around 1.3 million craters on the moon with a diameter greater than a kilometre, nearly 6500 were made by asteroids containing commercial quantities of platinum (*Planetary and Space Science*, doi.org/pqgt).

$1 trillion

The value of platinum and other metals stored inside lunar craters

This means that there are potentially "a lot more craters on the moon with ore-bearing asteroidal remnants than there are accessible ore-bearing asteroids", says Chennamangalam. At a rough estimate, he says there could be $1 trillion worth of platinum and other metals available for mining in lunar craters.

Mining the moon would be easier than asteroids, he says, because most asteroids are further away than the moon, and their negligible gravity would make operations technically difficult. The moon's gravity is only a sixth of that on Earth, but this would still make things easier.

However, even if lunar mining is technically easier, it may be legally more difficult. The Outer Space Treaty of 1967 remains the cornerstone of international space law, setting the rules for all activities beyond Earth – including space resource mining. It states that "outer space, including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means" – but it is disputed whether asteroids are "celestial bodies" or private mining is "national appropriation".

"While [the treaty] clearly applies to such activities, it leaves key questions unanswered," says Rebecca Connolly at the University of Sydney, Australia.

The US has recently attempted to clarify matters with a non-binding framework, known as the Artemis Accords, that establishes a set of principles governing the exploration and utilisation of outer space, particularly the moon, which would allow commercial exploitation. It has been signed by 55 countries, but not China or Russia, two major space powers, meaning there is still a lot of uncertainty.

"As private space mining and exploration activities loom near, it's critical that we bridge the gaps in the Outer Space Treaty to ensure clear, fair rules for resource activities at the multilateral level," says Connolly. ▮

Animal behaviour

Crafty cockatoos find new way to quench their thirst

COCKATOOS in Sydney, Australia, have learned to use public water fountains by twisting a handle, despite how difficult they are for birds to operate.

Sulphur-crested cockatoos (*Cacatua galerita*) have already learned how to open waste bins in eastern Sydney, leading to a battle of wits as humans try to keep their bins closed and the cockatoos again work out how to open them.

After rangers reported the same type of cockatoos using drinking fountains in western Sydney, Lucy Aplin at the Australian National University and her colleagues temporarily colour-marked 24 cockatoos – representing around a fifth of the local population – and filmed what happened at several drinking fountains.

KLUMPET AL. 2025

Cockatoos gather around a public drinking fountain in Sydney, Australia

Over 44 days, cockatoos made 525 attempts to use one particularly popular fountain. Of these, 105 attempts were by 17 of the 24 marked birds (*Biology Letters*, doi.org/pqgv). This suggests that about 70 per cent of the population of more than 100 birds tried to use the fountain, say the researchers.

Only 41 per cent of observed attempts ended in success – but drinking from the fountains is no mean feat for a bird, says Aplin. She thinks the birds are copying the behaviour from each other after one individual or a few individuals worked out how to do it.

The researchers saw queues of more than 10 birds waiting their turn along a fence, although dominant birds did jump the queue.

In natural environments, cockatoos drink from ponds or water collected in tree hollows near their roost, but these birds seem to be using the fountain instead. Aplin suggests it could be that the water tastes better there, or that they feel safer from predators. Alternatively, it may just be a fad driven by the birds' thirst for innovation. ▮

Chris Simms

New Scientist Live

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Comment

Bodily patriarchy

From Fallopian tubes to the G-spot, long-dead men have marked their territory when it comes to women's bodies, says **Adam Taor**

THE #MeToo campaign against sexual abuse of women went viral in 2017. Soon after, women had what I'd call an #AnatomyToo moment, when a toxic anatomical label was erased from women's genitals.

"Pudendum", a long-standing term for "vulva", the name for female external genitalia, was no more. Pudendum was emblematic of prejudicial attitudes to women among the traditionally male-dominated medical profession. Because, astonishingly, "pudendum" is from the Latin word *pudere*, meaning "to be ashamed". Anatomists designated this most intimate part of a woman's body as her most shameful.

But that isn't all. For hundreds of years, pudendum applied equally to women's and men's external genitalia. With time, men unburdened themselves of the label, leaving the naming and shaming especially for women.

In this context, it is hardly surprising many women feel insecure about their genitals. A UK survey found 65 per cent of young women had a problem saying "vulva" or "vagina". Body parts that dare not speak their name.

Names matter, as the gendered evolution of pudendum's usage illustrates. Hence, its purging from official anatomical terminology in 2019.

But pudendum is the tip of the iceberg when it comes to male dominance of the female anatomy. Inside a woman, there is a veritable frat club of distinguished gentlemen, in the form of anatomical eponyms: body parts named after people, almost exclusively long-dead men.

ADRIÀ VOLTÀ

A review of 700 body parts named after 432 people found 424 were male physicians. The eight eponyms that weren't male physicians comprised five gods, a king, a hero and just one woman: Raissa Nitabuch, a 19th-century Russian pathologist whose name is attached to a layer where the placenta separates from the uterus wall after delivery of a baby.

This bodily patriarchy isn't surprising, given the average date the parts were named was 1847, when women didn't get much of a look-in on our innards. Including women's reproductive real estate, where men particularly hold sway.

Gabriele Falloppio is memorialised in the tubes connecting the uterus and ovaries. Skene's glands – Alexander Skene – secrete female ejaculate into the urethra. The "G" in G-spot is Ernst Gräfenberg's while Bartholin's glands – Caspar Bartholin the Younger – are close to the vagina's opening and make fluid for sexual lubrication.

The masculine hegemony within the feminine is one reason why there have been calls for doctors to avoid eponyms in favour of more technically accurate terminology. Bartholin's glands are greater vestibular glands. Skene's glands are paraurethral glands. Fallopian tubes are uterine tubes.

However, anatomical eponyms are still commonly used, by doctors and the public. "Fallopian tube" won't be exiting the vernacular any time soon. And even if eponyms are frog-marched out of the relevant bodily orifices, other unfortunately named anatomical parts would remain.

While pudendum is kaput, the equally problematic "pudendal" is still a feature of the female, and male, anatomy, in the form of pudendal nerves, arteries, veins and canals. Not that many of us are intimately acquainted with them.

Unlike the vagina. Only a man could have named it "vagina", from the Latin for "scabbard". Admittedly a vagina rebrand isn't on the cards, but there aren't many who would miss the league of gentlemen that calls a woman's other reproductive parts home, if they were firmly requested to leave.

As for the pudendal nerves, arteries etc. well, there is only one word to describe their persistence in the anatomical lexicon. Shameful.

Adam Taor is the author of *Bodypedia: A brief compendium of human anatomical curiosities*

Notes from space-time

The big picture

The universe is still there to be understood, despite brutal new cuts to US science budgets. But the damage to future research will be huge, says **Chanda Prescod-Weinstein**

Chanda Prescod-Weinstein is an associate professor of physics and astronomy, and a core faculty member in women's studies at the University of New Hampshire. Her most recent book is *The Disordered Cosmos: A journey into dark matter, spacetime, and dreams deferred*

Chanda's week

What I'm reading
I'm halfway through Rickey Fayne's intriguing debut novel, The Devil Three Times.

What I'm watching
I love Mission: Impossible *and have watched every single film at least once in the past two weeks.*

What I'm working on
Drafting my third book, The Cosmos is a Black Aesthetic *(forthcoming from Duke University Press).*

This column appears monthly. Up next week: Graham Lawton

THE Stern-Gerlach experiment is, in my opinion, truly the first test that forced the results of quantum mechanics onto the scientific community. Proposed by Otto Stern and conducted by Walther Gerlach in 1922, it showed that atoms have a quantum structure. Electrons, it turned out, must follow quantum rules. The Stern-Gerlach experiment also highlights a weird feature of the quantum world: it seems that the observer can determine the possible properties a particle can have. If I measure a quantum property known as spin, the fact the measurement happened seems to change the possible values of spin a particle can have later. In other words, whether a particle was observed or not determines its future.

In physics, we are socialised to the idea that we are outside of the physical system, watching it. In this experiment, suddenly we aren't. In my experience, students initially absorb this as a fact they must accept. Only after being forced to think about it a few times do they realise it isn't consistent with their sensibilities about how reality works. Accepting the results is a surreal experience. Wonderfully surreal.

When I sat down and thought about how to communicate what it is like to watch the demise of US science in real time, "surreal" is the word that came to mind. It isn't the same kind of surreal as Stern-Gerlach, which feels like being re-introduced to reality – although you realise you had been living with a false sense of the world before, the new one is cool and exciting, so that's all right.

Our current political moment instead feels like realising that we had been living with a false sense of security – that US science and government support for it would be there tomorrow – but without a cool new reality on the other side. Instead, the US government is dispensing with publicly funded culture, throwing it into a black hole. I don't make that metaphor lightly; I think it's important. When an object crosses a black hole's event horizon, it is the point of no return. The object can't go back.

We are in the same situation. While the universe will still be there to be understood, the damage to our capacity for research will be long lasting and the alteration to our trajectory permanent. Already, a generation of master's and PhD students has had the number of available slots reduced. Aspiring professors aren't being trained in the same numbers; this affects not just future scientists but science communicators, too.

> **"The US government is dispensing with publicly funded culture, throwing it into a black hole"**

A whole future is being disposed of. And while Donald Trump's proposed cuts to NASA's astrophysics budget and the National Science Foundation's physics, mathematics and astronomy budgets won't keep the rest of the world from doing science, there will be far-reaching consequences. This is due to the US's role as a global investor in particle physics, cosmology and research into fundamental reality.

News of the devastating cuts to NASA's budget came out while I was attending the 2025 Natural Philosophy Symposium at Johns Hopkins University in Baltimore, Maryland. The event opened with a fascinating talk by philosopher and cognitive scientist David Chalmers, who spoke about the possibility of developing a mathematics of consciousness. He was followed by philosopher Sandra Mitchell, who spoke about the nature of human reasoning, and theoretical physicist Nima Arkani-Hamed, who said physicists should respond to being confused about the big picture by doing more calculations.

There we were, talking about the questions that have driven humanity for millennia: what is reality, and how do we engage with our study of that reality? Events like this highlight what is possible when we are given the space, time and financial resources to live in the world of ideas.

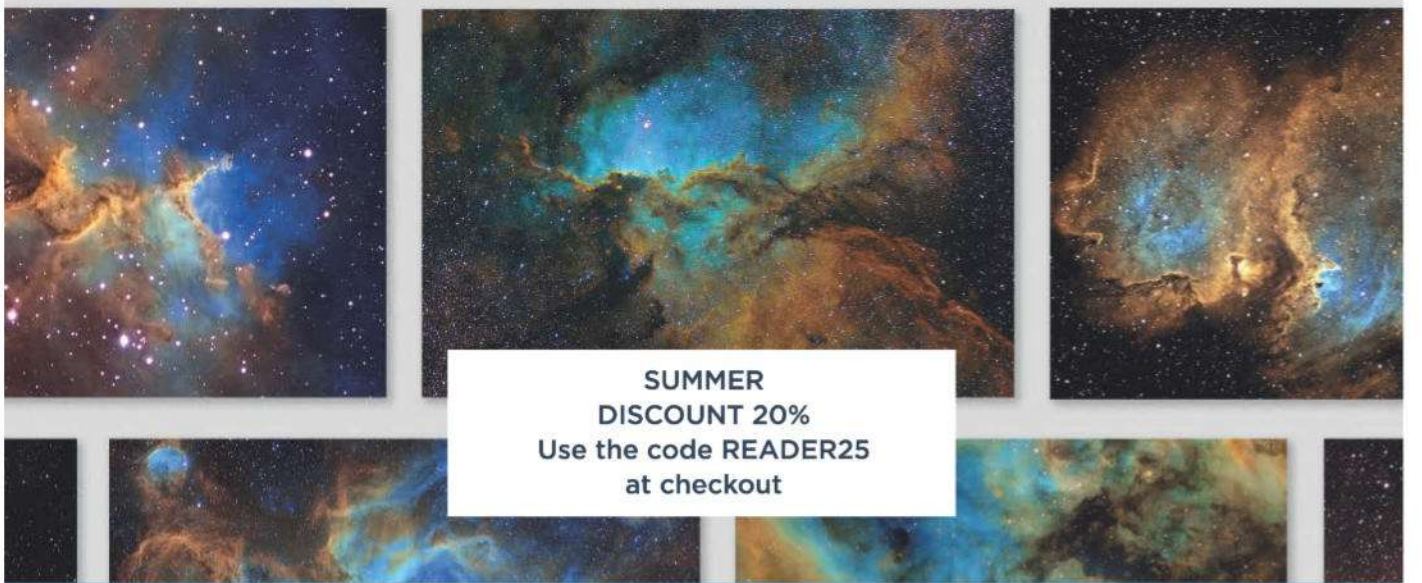
While we were there, NASA's astrophysics division was being readied for a bonfire. The potential damage will reverberate for decades. In 1922, Germany was the global epicentre of science. After the rise of the Nazis, who worked hard to remake German science in their image, that standing never fully recovered.

It is easy to read this as a story about a group of people with fancy degrees, sitting around in rooms and luxuriating in the universe of ideas. But these rooms make the people who write publications like this one. I was trained with the support of government Pell grants for poor and working-class undergraduates and a National Science Foundation Graduate Research Fellowship. The research I have written about in this column has been funded by three different federal agencies.

This surreal moment isn't just happening to US-based scientists and the US public. Because so much of the science we all read about comes from the US, it's happening to you, too. ▮

GALAXY ON GLASS

SPECTACULAR WALL ART FROM ASTROPHOTOGRAPHER CHRIS BAKER



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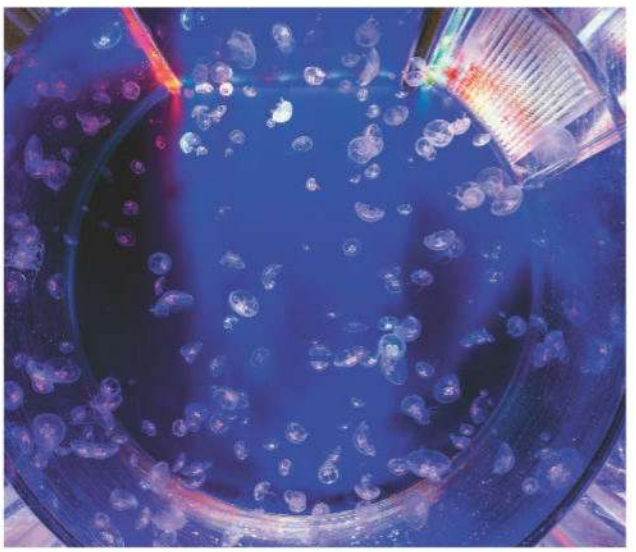

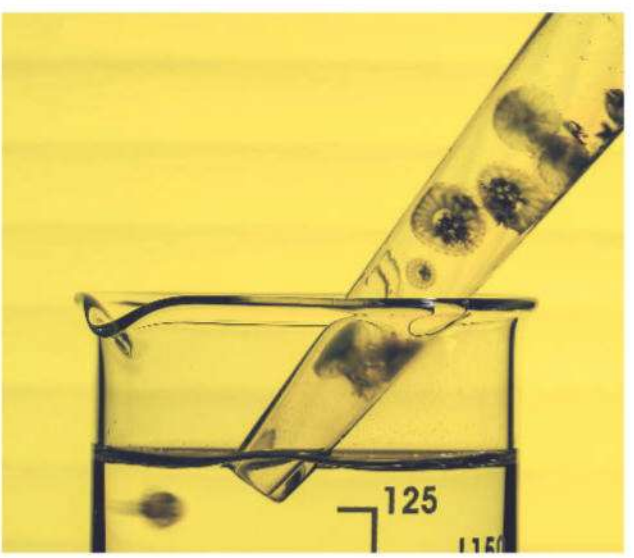

Bloom or bust

Photographers:
Heidi and Hans-Jürgen Koch

THESE eerily beautiful images show animals born at Europe's largest jellyfish breeding facility: Jellyfish Farm, in Künzell, Germany – hundreds of kilometres from any ocean.

Photographers Heidi and Hans-Jürgen Koch used macro lenses and studio flashes to capture the images, but they were most concerned with the positioning of the jellyfish, which sink to the bottom of a normal aquarium and thus wouldn't be photographable. The animals needed a "jellyfish *kreisel*", or gyroscope, to create water movement, without which they can't swim or feed.

Jellyfish drift "between being an environmental threat and a source of sustainable innovation", say the Kochs as part of their project. The number of blooms is increasing as oceans heat up and pollution and overfishing increase, with dire consequences for ecosystems and economies.

But jellyfish also present great opportunities: as animal feed, fertilisers or human superfoods, thanks to the anti-inflammatory and immunologically important biochemicals they contain. Their mucus can also create a biofilter to stop plastics from reaching the sea.

Pacific compass jellyfish (*Chrysaora fuscescens*) are shown at far left. They will be shipped to zoos, aquariums and research institutions. Moving clockwise, a gyroscope provides an ocean-like vortex for moon jellyfish (*Aurelia aurita*). Below, a pipette contains mangrove jellyfish (*Cassiopea xamachana*). As adults, they will live on the seafloor, their tentacles pointing to sunlight, helping single-celled algae there conduct photosynthesis. The bottom image shows jellyfish specimens being checked before dispatch.

Liz Else

Death of the private

How did we lose the sense that some parts of life should be off-limits rather than open to commodification? **Peter Hoskin** explores an insightful take

JAN KLOS/MILLENNIUM IMAGES, UK

How private are our lives in a highly surveilled world?

Book
Strangers and Intimates
Tiffany Jenkins
Picador
(UK, available now; US, 15 July)

WHATEVER happened to good old-fashioned privacy? Nowadays, practically everything about us is known, traded and exploited by social media platforms, even when we aren't opening the curtains on our inner lives ourselves. Click. There's the sourdough your smug uncle made this morning. Click. There's your friend crying about a missed promotion. Click. There's a stranger inviting you – for a fee, of course – into their bedroom.

You would expect a book called *Strangers and Intimates: The rise and fall of private life* to have views on all of this – and it does, except that they are less straightforward, more considered and much richer than most others in this area.

As its author, the cultural historian Tiffany Jenkins, puts it: "Many blame this situation on narcissistic individuals who broadcast their lives online or on tech companies that devour personal data, but this overlooks the deeper changes at play." And hers is a text about those deeper changes.

In Jenkins's account, these mostly took place in the 20th century – and they were multifarious. Chapters are devoted to everything from the prying capabilities of smaller cameras – "Kodak fiends" were a particular turn-of-the-century nuisance – to the broader implications of Bill Clinton's trysts with Monica Lewinsky – the private suddenly became fiercely political.

Among the book's highlights is its story of how radical US groups in the 1960s, such as the Students for a Democratic Society (SDS), fought for personal independence only to end up killing it. As the SDS demanded purer and purer participants, one activist couple was even reprimanded for the terrible crime of "flagrant monogamy".

Scientific thinkers aren't exempted from this narrative. The behaviourist trinity of Paul Lazarsfeld, Edward Bernays and Ernest Dichter receive special attention for their collective work, in the first half of the 20th century, to turn humans into data and data into marketable insights. None of them acted maliciously, but they helped erode the sense that certain parts of life should be off-limits, rather than grist for corporate interests. Much the same could be said of biologist Alfred Kinsey's famous surveys of people's sex lives. Is nothing sacred?

"We have allowed our two worlds to become compromised and blurred. The private is increasingly public"

Of course, privacy didn't face a straight decline in the 20th century. It adapted, it moved, it pushed back. Jenkins dwells on cases such as Griswold v. Connecticut (1965) and Katz v. United States (1967), which established important protections for US citizens against state interference. She understands that her subject is complicated – encompassing law, culture, technology and even housing policy – and embraces that fact.

But there is no escaping Jenkins's conclusion that privacy has declined overall, not least because the first half of the book does such a thorough job of charting its preceding rise.

Starting with the revolutionary appeals to personal conscience by Martin Luther and Thomas More in the 16th century, and continuing through various religious and personal freedoms in the 17th century, *Strangers and Intimates* really lands a century later.

It was, argues Jenkins, the 18th century that "heralded the arrival of public and private realms", two distinct areas of life that allow for two distinct sides of the human character. In fact, the book even suggests, persuasively, that this development trumps all others of the Enlightenment. This is the sort of history book that makes you look at all history anew.

Which brings us right back to our highly surveilled present. "Had there been a strict separation between the public and private worlds when the world wide web took off," argues Jenkins, "the online world today would be very different." Since the 18th century, we have allowed our worlds to become compromised and blurred. The private is increasingly public.

And what do we stand to lose? Many things – although they aren't all gone yet. "Originality begins in private," writes Jenkins in her epilogue. From which we can only surmise that *Strangers and Intimates* began with blessed privacy. ▮

Peter Hoskin is books and culture editor at *Prospect* magazine

Going nuclear

The history of the atomic age gets a welcome rework in this book, which includes more about the role of women, finds **George Bass**

Book

Destroyer of Worlds
Frank Close
Allen Lane (UK); Basic Books (US)

WHEN particle physicist and University of Oxford professor emeritus Frank Close learned he had non-Hodgkin's lymphoma in 2023, his treatment included three weeks of radiotherapy, giving him a fresh perspective on radiation's power.

Later, his 10-year-old grandson gave him a fulsome account of the Tsar Bomba – the 50-megaton nuclear weapon tested by the Soviet Union in 1961, and, to date, the most powerful human-made explosion. For Close, it was time to write an account of nuclear energy and its value as a double-edged sword, one with the power to heal ailments and kill billions at a stroke.

As a three-time winner of the Association of British Science Writers prize, Close knows his subatomic onions. *Destroyer of Worlds: The deep history of the nuclear age 1895-1965* begins with the Trinity test blast of July 1945 – when detonations ceased to be solely chemical. Then he jumps back, covering events like the first atomic imprint on a photographic plate in 1896, and his journey into the nuclear age begins.

There is the tale of 19th-century scientist William Crookes who, grieving and drawn to spiritualism after his brother's death, observed "luminous green clouds" inside a charged vacuum tube filled with gas. He assumed he had synthesised ectoplasm and proved the existence of phantoms. Theorist George Gamow also makes an appearance, with his evidence that uranium could release positively charged alpha particles without violating the principle of energy conservation.

Close's main focus, however, is the female physicists who escaped their share of the nuclear limelight. He explains how, despite her PhD, Lise Meitner wasn't allowed into the upper, male-only rooms of the University of Vienna during her tenure. That didn't deter her from working with Otto Hahn to provide X-rays to wounded troops during the first world war, or from discovering element 91, protactinium, in 1917. Five years later, Meitner became Prussia's first female *Privatdozent* (an academic, albeit non-salaried), and in 1925 won a Lieben prize.

The book also profiles Irène Joliot-Curie, daughter of Marie Skłodowska-Curie and Pierre Curie, who inherited her parents' scientific talents. In 1910, Marie was involved in a scandal over an affair with a married physicist and was denied membership of the French Academy of Sciences. In the fallout, Irène tried to restore the family's legacy, and Close describes the research she did with her husband Frédéric Joliot, in which the pair glimpsed (but failed to fully identify) the neutron. The 1932 unveiling of that particle by James Chadwick is "the moment when the science of nuclear physics began", writes Close.

In another section, he sheds light on chemist Ida Noddack's claim that uranium nuclei could be broken into isotopes of lighter elements. When she went on to argue that these nuclei could be split to create nuclear fission, she was branded a crank by her peers. Noddack was targeted, Close implies, not just as a woman, but as an industrial chemist from a turbine factory stepping on the toes of the nuclear physics elite.

***Destroyer of Worlds* tries to live up to the jeopardy of its title by attempting to solve the mystery of Ettore Majorana, a theoretical physicist described as a genius, "like Galilei and Newton" by Enrico Fermi, creator of the nuclear reactor. Majorana vanished in 1938, and his absence sparked rumours ranging from suicide to becoming a monk to fleeing the fascism engulfing Italy. Close, like others before him, can't get a definitive answer.**

Today, one fact is clear through the radioactive fog: it took many great minds to release the nuclear genie from its lamp, and for better or worse, there's no putting it back. ▮

SMITH ARCHIVE/ALAMY

Irène Joliot-Curie and her husband Frédéric Joliot caught a glimpse of the neutron in their experiments

George Bass is a writer based in Kent, UK

New Scientist *recommends*

Penny Sarchet
Managing editor
London

It has been a sunny spring in London, the perfect time to explore the overlap between gardening and science in the Avanade Intelligent Garden at **RHS Chelsea Flower Show**, which closed on 24 May.

THE BRITISH LIBRARY BOARD

Each tree in this urban forest sported an arboreal "smartwatch", which tracked its growth, lean angle and more. An AI dashboard monitored the trees, ready to flag any warning signs.

This is no gimmick: studies suggest perhaps the majority of urban trees die 15 years or less after planting. We know trees benefit air quality, wildlife and well-being, but many are stressed and poorly tended. Are smart tree monitors the answer? Take a look as the garden relocates to Manchester later this year.

Gardening technology isn't new. At the British Library's new **Unearthed** exhibition, I marvelled at a rare Wardian case (a mini-greenhouse used to ship plants to Victorian England) and at a 600-year-old predecessor of a watering can. Shown above is a 17th-century painting of a sunflower featured in the exhibition.

The sci-fi column

Future present Time travel is real, and a young woman is hired as a "bridge" to help a naval commander adapt to the 21st century after he is snatched from death in 1847. Find out how they fare in the fabulous *The Ministry of Time,* says **Emily H. Wilson**

Emily H. Wilson is a former editor of *New Scientist* and the author of the *Sumerians* trilogy, set in ancient Mesopotamia. The final novel in the series, *Ninshubar*, is out in August. You can find her at emilyhwilson.com, or follow her on X @emilyhwilson and Instagram @emilyhwilson1

PICTORIAL PRESS LTD/ALAMY

A 19th-century painting of John Franklin's doomed ship Erebus, trapped in ice

Book

The Ministry of Time

Kaliane Bradley

Sceptre (UK); Avid Reader Press (US)

Emily also recommends...

Book

The Persian Boy

Mary Renault

Virago Modern Classics

This isn't sci-fi, of course; it's historical fiction. But it does bring another historical figure to life – Alexander the Great, seen through the eyes of an enslaved Persian boy, Bagoas. For me, this book and its prequel are the only ones you will ever need to read about Alexander.

New Scientist Book Club

***The Ministry of Time* is our new read. Sign up here: newscientist.com/bookclub**

WHEN you read a lot of novels for work, as I do, it can be hard to get into a new one at first. You have to push on. But *The Ministry of Time* by Kaliane Bradley had me right from its teeny tiny prologue. Just 150 words or so about a man trudging through snow and hearing his ship signal to him, and somehow I was there. That's some trick to pull off.

The book, this month's pick for the New Scientist Book Club, has proved itself a smash hit since publication last year, and rightly so. It is the story of a young civil servant who applies for a new job not knowing what it entails. It turns out time travel has been invented, but is being kept secret, and people have been moved from the past into the present.

These "expats" need some looking after, as you might imagine, and so our unnamed heroine is to become the caretaker, or "bridge", for one of them. His name is Commander Graham Gore, and she must live in a house with him and help him fit into the world as it is now.

This isn't a book that dwells on the mechanics of time travel or examines too closely whether any government would really let time travellers out into the world with only a civil servant to look after them. But the novel sets out with such confidence that this reader, at least, was able to sally forth without worrying about details.

> **"Modern London is a lot for a man from a lost world to take in. But Gore is a resilient and can-do officer"**

Now, a piece of genius at the heart of the book is that Gore is (or rather, was) a real person, although not one most people will have heard of. He was first lieutenant of John Franklin's ill-fated expedition to the Arctic, and he died in either 1847 or 1848. The exact details of the expedition's last days are unclear. In this novel, however, he is snatched away just before death, and thrust into modern London.

Bradley's rendering of Gore is the second piece of genius in the book. She describes him so brilliantly that he leaps from the page as a real, breathing, passionate, fantastically brilliant and interesting man. It is rare indeed to find a character so vividly drawn in a novel.

And so our young bureaucrat and this vibrant officer of the colonialist Royal Navy must enter into a house-share. London, or this near-future version of it, is quite a lot for a man from a lost world to take in. But then again, Gore is a resilient and can-do officer, and if anyone can adapt, he can. This is by far the most enjoyable part of the novel, as the two muddle along, each teaching the other something about their world.

The book morphs into a love story and then a thriller. It probably ends up as about 40 per cent sci-fi, 40 per cent romcom and 20 per cent thriller. I preferred the first section by far, and wasn't sure the thriller-y ending really worked. But none of that obscures the fact that the book is a delicious treat, so if you are looking for something really enjoyable to read, look no further.

At the end of the novel, Bradley includes a copy of a photograph of Gore. I found it very moving to see him there, as he actually was, after getting to know a fictional version of him so well. According to Bradley's postscript, he was described by one contemporary as "a very good officer, and the sweetest of tempers".

What an extraordinary twist of history that this sweet-tempered officer should end up in a bestselling novel almost 200 years later. Bradley has certainly made the most delightful hero of him. ▮

Editor's pick

On the enduring threat of nuclear annihilation

24 May, p 21

From Roger Orpwood, Leigh on Mendip, Somerset, UK

Mark Lynas's article on the risks of nuclear war was refreshing. The threat of annihilation hangs over us every second of every day, but it seems that politicians and the media prefer to pretend it is all OK.

As a design engineer, I know too well the impossibility of developing systems that never go wrong. Nuclear weapons, with their launch-on-warning provisions, constitute one of the most complex systems we have ever developed. It will, of course, go wrong at some point. And that will be the end. As Lynas rightly concludes, we have to get away from the groupthink that can't see any alternative to the insanity of basing our security on the threat to destroy ourselves.

From John Bailey, Blackwater, Hampshire, UK

While Lynas's hopes and wishes are admirable, with Vladimir Putin threatening the use of nuclear weapons and Donald Trump promising to "drill baby, drill", I fear that the Fermi paradox is secure in its implication that technological civilisations tend to destroy themselves in short order, and that nuclear war and climate change are inevitable. Maybe we should accept this and enjoy ourselves while the going is good.

From Bruce Mardle, Wroxall, Isle of Wight, UK

UK governments have long favoured multilateral nuclear disarmament. However, it always seems to boil down to: "You first."

Mars is a hellscape well worth avoiding

17 May, p 26

From Willem Windig, Rochester, New York, US

Reading the book review of *Out of This World and Into the Next*, I saw the term "terraform". The general story behind its use is: "We aren't able to keep Earth's climate under control, so we go to another planet, where we first need to get the climate under control through terraforming." Considering the experiences with making far-away places suit our modest needs, as in colonial times, "terrarizing" seems a more appropriate word. The practitioners of this noble art would be called terrarists.

From Rayson Lorrey, Rochester, Minnesota, US

You rightly threw cold water on the romanticism of colonising Mars. Sci-fi offering *The Expanse* was mentioned as a tonic to such visions. Its Martian colonists sensibly began to flee the Red Planet as soon as green worlds became available (thanks to alien tech). Why abandon our own green world for a hellscape?

Hold-ups on the way to a car-free paradise

24 May, p 22

From Sam Edge, Ringwood, Hampshire, UK

I couldn't agree more on the need to reduce town centre traffic. In the UK, motoring bodies like the Automobile Association and Royal Automobile Club tend to resist efforts to cut car use. In Germany, the equivalent body, the ADAC, does the same. At least in Germany there is the ADFC, which pushes back on behalf of cyclists. Perhaps it is time for a UK Royal Pedestrian Club and a Cyclists' Association.

From Cheryl Hillier, Cribyn, Ceredigion, UK

The compelling case to reduce car use is the exact same powerful argument to incentivise the affordable public transport needed to replace individual car use. Unfortunately, rural areas have suffered from inadequate provision for so long that it is virtually impossible to live anywhere other than an urban conurbation without a car. Once you are funding car ownership, you are already paying through the nose for your transport needs. Paying additionally for public transport, whatever the expense, becomes an additional cost you can ill afford. Any directive to reduce car use and cut emissions and pollution must come with viable and affordable alternatives.

From John Phillips, Forres, Moray, UK

The urban car problem can be solved with app-based ride services that can hold many passengers. Individual city cars could be totally replaced, leaving suburban roads clear for walking and cycling, as well as removing parked cars. An "out-of-town" hire scheme could cover other car journeys. By relinquishing a car (or two), a local family would save thousands a year – more than the cost of the taxi services! What's not to like?

Scent therapy is not to be sniffed at

24 May, p 30

From Geoff Harding, Sydney, Australia

Surely what is beneficial in maintaining a healthy brain is continual stimulation via all the senses, not just smell. Some stimulation, such as studying and practising a second language, may be more effective, but only long-term research will elucidate their relative effectiveness. That said, the benefit of developing the olfactory sense looks promising, and little more encouragement should be needed to boost it by deliberately stopping to smell the roses – and every other (preferably pleasant) odour one can.

From Malcolm Hunter, Leicester, UK

So pleasant smells can help reduce chronic inflammation, and being able to smell unpleasant things can help us avoid health threats and stimulate the immune system when necessary. There is also evidence that a declining sense of smell or its loss may be addressed by regularly exposing people to a wide range of scents. However, all the programmes described use only pleasant scents. Wouldn't more stimulation be provided by also including unpleasant ones? I wonder if their exclusion may lead to lopsided recovery of this sense.

Instant quantum comms a non-starter

Letters, 31 May

From Eric Kvaalen, Les Essarts-le-Roi, France

Roger French asks whether anyone is working on using quantum entanglement to achieve instant communication with Mars. But entanglement can't be used to transmit a signal. All it means is that if someone on Earth measures a property of one particle and someone (or an avatar) on Mars measures that property of another particle that is entangled with the first, the results will be the same.

One simple trick to keep eyes dry chopping onions

24 May, p 12

From Bonita Ely, Sydney, Australia

You report a study that suggests an optimal way to chop onions without crying. Forget slow cuts with sharp blades, black spray paint, electron microscopes and such like – just slice the top and bottom off the onion, soak it in water, chop. No tears. Easy-peasy.

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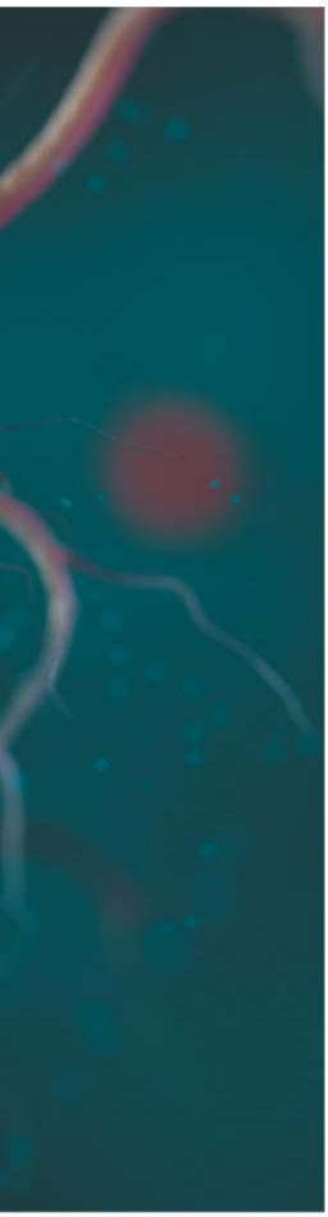
SPOOKY POOKA

Cancer's nerve centre

The discovery that nerve cells help tumours grow and spread is leading to new treatments using familiar drugs, finds **Carissa Wong**



THE video I am watching feels like a scene from a horror movie. At the centre of the screen is a blood-red mass – in reality, a massively magnified pancreatic tumour, vividly dyed as if to highlight its malevolence. It crawls around, luring in a purple tendril, which is actually the long, spindly arm of a living nerve cell. When the mutant growth has this in its grasp, it slowly rolls along the filament towards the neuron's bulbous body. Once there, things will become even more sinister. The cancer will take shelter, steal nutrients from the neuron and replicate itself. "It's very creepy," says William Hwang.

Hwang, whose team at Harvard University recorded this footage, has recently joined a growing number of scientists in the new field of cancer neuroscience. They are mapping out interactions between tumour cells and the nerve cells surrounding them – and shattering the long-held belief that these are of little significance. In fact, their findings reveal that nerves play a central role in cancer: they help tumours grow, increase their ability to spread around the body and even undermine the immune system's efforts to fight the disease.

While some of the ways that tumours manipulate nerves are truly chilling, a growing understanding of this cellular dialogue is inspiring new cancer therapies. This field is so hot right now that two researchers have just been awarded the world's largest prize for neuroscience research. "There has been an explosion of interest in cancer neuroscience in the past decade," says Erica Sloan at Monash University in Melbourne. "I think this will be the next big thing in cancer treatments."

Cancer researchers first found nerve cells in tumours in the late 1890s, but this insight was shelved for more than a century. Then, pathologist Gustavo Ayala, now at the University of Texas Health Science Center at Houston, decided to take a closer look. While waiting for his medical licence in 1998, he became curious about a mysterious phenomenon he had seen time and again called perineural invasion. It describes how the most aggressive cancer cells tend to wrap around and migrate along nerves – just like in the video Hwang showed me. At the time, clinicians had already linked this to poorer survival outcomes. "But nobody knew how it happened," says Ayala. In search of answers, he mixed human cancer cells and mouse neurons in a lab dish. What he saw astounded him. The cells grew towards each other, establishing a mutual connection that fuelled the growth of both. "It was a eureka moment for me," he says.

Unfortunately, most other cancer researchers didn't see it that way, too busy focusing on unpicking the genes that drive cancer to pay much attention to nerves. Undeterred, Ayala continued his work and, in 2008, he and his colleagues showed that tissue samples taken from the prostates of men with prostate cancer contained more nerves than healthy prostate samples.

Another milestone came in 2013, thanks to the findings by Claire Magnon at the French National Institute of Health and Medical Research in Paris and her colleagues. They had injected human prostate cancer cells into mice and found they could halt tumour growth by slicing out nerves around the prostate or destroying them with a chemical.

"That was an eye-popping experiment," says Elizabeth Repasky at Roswell Park Comprehensive Cancer Center in New York state. "It really showed that tumours require nerves to survive, just like they need blood vessels or oxygen."

Secret weapon

A year later, Timothy Wang at Columbia University in New York City and his colleagues managed to slow tumour growth in mice by blocking nerve signals from reaching stomach tumours – either by using Botox or by cutting the nerves. In combination with chemotherapy, this increased the animals' chances of surviving for more than a month by more than 20 per cent compared with mice that had only chemotherapy.

"Since then, the field has really grown remarkably," says Wang. A slew of mouse studies showed that many types of tumours, including breast, skin and pancreatic, lure nearby nerves into their lair and then feed on proteins called growth factors that the neurons produce. This sets up a vicious cycle, where larger tumours recruit even more nerves and grow even bigger on their growth factors. "We now think of cancer more like an organ," says Wang. "Every organ or limb requires nerve outgrowth to develop – so the idea that nerves are the master controller of cancer growth makes a lot of sense."

However, unlike organs, tumours don't always stay in one place; cancer cells often spread to distant sites, making treatment especially difficult. And it turns out that nerves can encourage this migration, too. When Sloan and her team used a drug to amplify signals ›

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in nerves in mice, they found that this more than doubled the spread of breast cancer to the lungs. The neural signals appear to increase the growth of tubes called lymphatic vessels that drain fluid from tumours. This, in turn, provides the cancer with additional routes through which to migrate. "You get many more pathways for cancerous cells to escape," says Sloan. Dampening these signals with beta blockers – common drugs that are used to treat heart failure, anxiety and migraines – had the opposite effect.

It gets worse, though. The same neural signals also seem to suppress the body's own defences against cancer. Repasky and her colleagues have found that they push cancer-fighting immune cells called T-cells to a state of exhaustion, making them less able to destroy tumours. "When the immune cells get to the tumour, nerves are there – and one function of those nerves is to suppress the immune system," says Repasky. And in a "double whammy", she says, the same nerves also boost the activity of another type of immune cell that supports tumour growth.

A mountain of evidence in mice now points to neurons as allies of cancer – but the crucial question is whether the same things are happening in people. To explore this, researchers have taken several approaches, including analysing tumour samples and finding that people whose growths contain more nerves tend to die sooner from the disease. They have also found that spinal cord injuries seem to reduce the risk of some cancers, presumably by disrupting nerve signals to tumours. In a meta-analysis involving more than 35,000 men with spinal cord injury and more than 158,000 men without, the former had about half the risk of prostate cancer as the latter.

Yet more evidence comes from people taking beta blockers. For example, in 2021, Sloan's team sifted through the health records of more than 4000 women with heart conditions who also had breast cancer. At the time of their cancer diagnosis, 136 were already taking the beta blocker carvedilol. More than five years later, these women were about half as likely to have died from their cancer as those who hadn't taken beta blockers. Admittedly, other factors may have influenced the results, such as people's dietary or exercise habits. Nevertheless, Sloan thinks there is a real signal: "If you look at the now hundreds of beta blocker studies across lots of different cancer types, on the whole, they show a protective association or they don't find any link, and not too many show an adverse one."

Recent research even suggests why these results are variable: different tumour types respond distinctly to various branches of the nervous system. For instance, so-called sympathetic nerves, which coordinate the fight-or-flight response, are key drivers of growth in breast, ovary and prostate cancers. On the other hand, parasympathetic nerves, which underpin the body's rest-and-digest response, seem to slow the growth of breast and pancreatic cancer. "They've got this yin and yang," says Wang.

But the picture is far from simple: parasympathetic nerves can promote the growth of stomach, prostate, head and neck cancers. Moreover, in a new study, Wang found that sensory nerves, which detect things like pain, temperature and the state of internal organs, spur the growth of stomach cancer. And it gets weirder: tumours can also make nerve cells switch from one type to another. In 2020, researchers showed that tongue cancer cells shuttle short genetic codes into sensory neurons, causing them to behave more like sympathetic neurons, which more strongly support the tumour's growth.

DR P. MARAZZI/SCIENCE PHOTO LIBRARY

KLAUDIA RADECKA/NURPHOTO VIA GETTY IMAGES

Top: Radiotherapy is currently used to treat prostate cancer

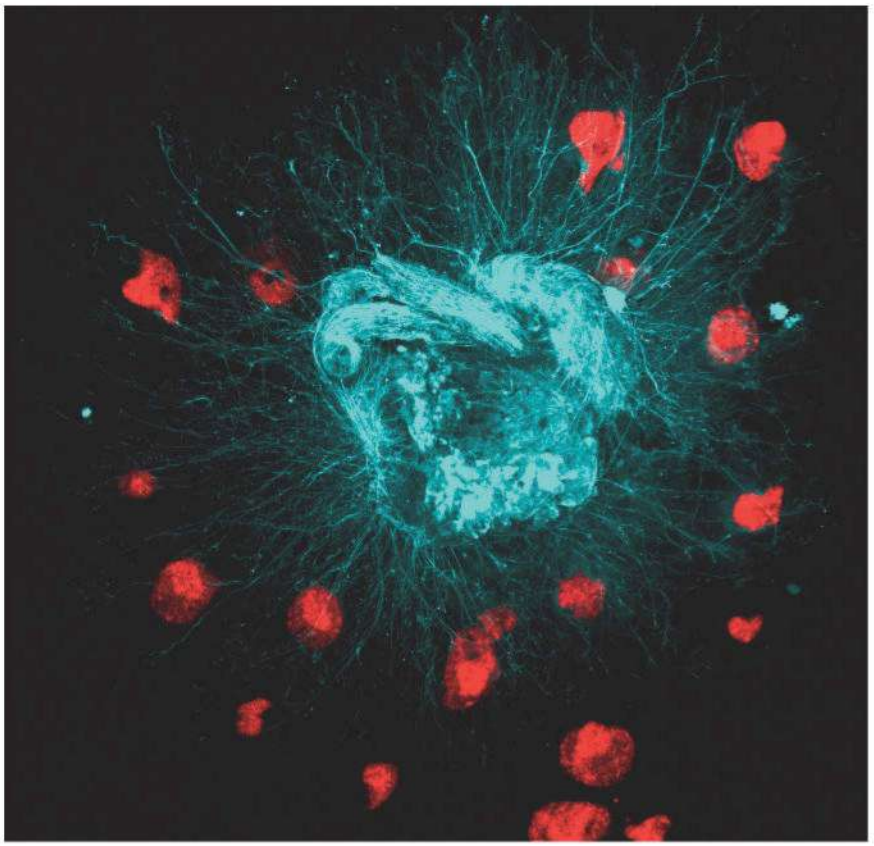
Bottom: Breast cancer tumours, being screened for here, are among those where beta blockers show promise as a treatment

Electric spark

In a further twist, some cancer cells can acquire neuron-like properties, allowing them to directly tap into the nervous system's electrical activity. This discovery was made independently in two groundbreaking studies of brain cancers published in 2019. It is this work that won the 2025 Brain Prize, which is worth €1.3 million, for Frank Winkler at the German Cancer Research Center in Heidelberg and Michelle Monje at Stanford University in California. Winkler and his group collected samples of one of the most lethal cancers – glioblastoma – and mixed these with healthy neurons in a lab dish. Then they electrically stimulated the neurons, causing them to release potassium ions, which nerve cells do when generating an electric current. The surprise, however, was that this sparked electrical activity in some of the tumour cells, which then amplified the electric signals among them.

Since then, evidence has emerged suggesting brain tumours that are more electrically active are also more lethal. Research found that people whose tumours were highly synced with the electrical activity of healthy regions of their brains survived an average of 71 weeks after diagnosis, whereas those with less electrically active tumours survived for an average of 123 weeks. "The brain cancer is modulating electrical networks in a way that's determining patient outcome," says Winkler.

That's not all. In their 2019 studies, Winkler and Monje also discovered that some brain cancer cells can form junctions called synapses with healthy neurons. Until then, synapses had been thought to be exclusively a feature of neurons and some of the cells that help them to function, allowing them to transmit messages from one to another by releasing chemicals. So, the researchers were shocked to observe tumour cells developing these structures and using them to fuel their growth. "We found something crazy," says Winkler. When Monje's team used an epilepsy drug called perampanel to block signals sent across the synapses that had formed between cancer cells and neurons,



PETER WANG

Mini-pancreatic tumours (coloured red) interact with neurons, which provide chemicals that help them grow

this halved tumours' growth rates.

Winkler and his team have since found that – in mice at least – synapses can also form between healthy neurons and skin and breast cancer cells that have spread to the brain. In a study that has yet to be peer-reviewed, they showed that disrupting these synapses with perampanel reduced the number of brain tumours by a tenth. And just this year, Wang's team found synapses between sensory nerves and stomach cancer cells. Again, these fuelled tumour growth.

Amid this flurry of insights, researchers have begun to set their sights on the clinic. "What I'm most interested in is making a difference to patients," says Sloan. In 2020, she and her colleagues randomly assigned 60 women who were newly diagnosed with breast cancer to take either a daily dose of the beta blocker propranolol or placebo pills. Analysing tumour samples excised from the women a week later, the team found the cancer cells to be substantially less aggressive, and less likely to spread, in those who had taken propranolol. Tumours from this group also contained more immune cells that help to destroy cancer. "That's only from seven days of treating them with a beta blocker to block neural signalling – so just imagine how longer-term treatment with these drugs could potentially affect the cancer," says Sloan.

Repasky has also seen promising results from an initial trial that tested propranolol in combination with immunotherapy in nine people with skin cancer. The tumours' responsiveness to the combination therapy was almost twice what the researchers had anticipated based on previous immunotherapy-only studies, "meaning more of their tumours either shrank or disappeared than we anticipated," she says. The researchers are currently conducting a larger phase II trial, with results due later this year. Repasky is also trialling the approach against breast cancer, oesophageal cancer and multiple myeloma, which develops from plasma cells in bones.

Meanwhile, Winkler is testing epilepsy and arthritis drugs that either interfere with cancer-neuron synapses or electrical signals in cancer cells to find out whether they can benefit people with glioblastoma. (Intriguingly, his team has just reported that the drug nab-paclitaxel, which is a standard chemotherapy treatment for breast and pancreatic cancers, may work in part by disrupting cancer-neuron interactions.)

Many of the drugs being trialled are "very inexpensive, widely available, and well tolerated", so they have a real chance of success, says Sloan. But there is one major roadblock: pharmaceutical companies are reluctant to fund trials that repurpose drugs with expired patents. "There's no money to be made," says Sloan. To get around this, Winkler and his team are designing novel drugs to treat brain cancers using insights gained from research in mice on drugs that seem to have the potential to tackle a variety of cancers. However, Repasky argues there is another way to entice Big Pharma companies: potentially finding that their newer drugs are more effective when taken in conjunction with existing ones. "That would be a marketable idea", she says.

It is an exciting time for cancer neuroscience. And my meeting with Hwang left me with another intriguing thought. If the pain some people experience with cancer is linked to nerves within their tumours, perhaps drugs that target these nerves can also act as painkillers. Hwang's team is currently exploring this: "The idea is that at the same time we're treating your cancer, you're also feeling much better," he says. "You can't say that for a lot of treatments being developed." ▮

"Tumours require nerves to survive, just like they need blood vessels or oxygen"

Carissa Wong is a health reporter at *New Scientist*

Tutankhamun's death mask was made from gold and semi-precious stones

The bling king

Tutankhamun had an opulent tomb despite being only a minor pharaoh. Now we may know why he was given such a lavish send off, says **Colin Barras**

A CENTURY ago this October, Egyptologist Howard Carter and his colleagues opened the innermost coffin of the pharaoh Tutankhamun's sarcophagus for the first time in almost 3250 years. Inside they discovered the boy king's mummy wearing an incredible mask fashioned from gold and semi-precious stones.

Tutankhamun's fame today stems largely from the discovery of his tomb, which was filled with lavish goods – not only the magnificent funerary mask, but chariots, statues and even a dagger crafted using iron from a meteorite. In truth, though, he was a relatively insignificant pharaoh with, in turn, a presumably austere burial. That he was interred with such riches raises an intriguing question: What treasures might a truly important pharaoh have taken to their grave?

Carter wondered this, too. "How great must have been the wealth buried with those [other] ancient Pharaohs!" he would later write. Sadly, this is something we still don't know for sure, as almost all other royal tombs were plundered and their grave goods lost.

But now, one Egyptologist has put forward a surprising explanation for the conundrum of the opulence of Tutankhamun's interment.

According to Peter Lacovara, thanks to an intriguing combination of factors, this obscure king's tomb may actually be the richest of any pharaoh's in ancient Egypt's 3000-year-long existence. "Even King Khufu in the Great Pyramid of Giza would never have had anything approaching the quantity of material in Tutankhamun's tomb," he says.

Putting this idea to the ultimate test would require comparing the contents of Tutankhamun's tomb with those of another pharaoh who reigned at about the same time. Remarkably, such a comparison might soon be possible: researchers could be poised to unearth an untouched royal tomb purportedly belonging to Tutankhamun's great-great-great-great grandfather, Thutmose II.

It was on 28 October 1925 – three years after the discovery of Tutankhamun's tomb – that Carter and his colleagues were finally ready to open the pharaoh's solid-gold coffin. Carter was clearly impressed by the richly adorned mummy he found within. "Time... seemed to lose its common perspectives before a spectacle so vividly recalling the solemn religious rites of a vanished civilisation," he wrote.

All the same, it is easy to understand why Carter harboured suspicions that many other pharaohs had enjoyed even wealthier burials. Tutankhamun reigned for less than 10 years, dying in his teens before he could commission grand monuments or make his mark militarily. Nicholas Brown at Yale University says this means he "ranks down near the bottom of the list" of pharaohs in his particular branch of the royal family – known as the 18th dynasty, whose members ruled ancient Egypt from the mid-16th to the early 13th century BC. In line with this, he has one of the smallest tombs in the Valley of the Kings, near modern Luxor, measuring only about 110 square metres.

This is in stark contrast with the vast tombs of the kings known as the Ramessides, who reigned in the centuries after the 18th-dynasty pharaohs. The tomb of Ramesses III in the Valley of the Kings, for instance, has more than four times the footprint of Tutankhamun's. However, Lacovara suggests that this tomb, despite its size, may never have contained as many grave goods as Tutankhamun's.

Tombs like Ramesses III's had grand entrances. "They were visibly on show," says Lacovara, who is the director of The Ancient Egyptian Archaeology and Heritage Fund, a US-based non-profit organisation. He suspects this is because these tombs – unlike Tutankhamun's – were designed to be visited, probably by priests who would continue to honour the pharaoh even in death. As such, he argues that these tombs were unlikely to have housed many treasures because they would have been an easy target for thieves; Tutankhamun's treasure-filled tomb, meanwhile, was sealed and carefully hidden. "Certainly, the 18th-dynasty tombs were better hidden than their later Ramesside counterparts," says Joann Fletcher at the University of York, UK.

Nevertheless, we know Carter was correct to suspect that many other royal tombs contained impressive artefacts. While most of those tombs were plundered in antiquity, a few escaped the attention of ancient robbers.

For instance, back in 1925 – just months before Carter and his colleagues opened Tutankhamun's gold coffin – a team of researchers working in the shadow of the Great Pyramid of Giza discovered a cache of royal funerary treasures belonging to Queen Hetepheres, a 27th-century BC royal and Khufu's mother.

Treasure trove

Hetepheres's treasures include finely made silver bracelets inlaid with royal blue lapis lazuli and a gold-covered box. "They are quite beautiful," says Josef Wegner at the University of Pennsylvania.

Then there is an intact royal tomb discovered in northern Egypt in the late 1930s, containing the untouched mummies of three pharaohs from the 11th, 10th and 9th centuries BC. The solid-gold burial mask of one of these pharaohs – Psusennes I – bears a striking resemblance to the famous mask of Tutankhamun.

Treasures like these offer a priceless window into the artisanal skills and belief systems of ancient Egyptians. But they also suggest the objects from Tutankhamun's tomb are among the finest the civilisation ever produced.

Take Tutankhamun's iconic gold burial mask. A decade ago, Christian Eckmann and Katja Broschat at the Leibniz Centre for Archaeology in Germany and their ›

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colleagues, all specialists in ancient manufacturing techniques, were given the opportunity to study the artefact as part of a restoration project. The researchers, who published their findings in 2022, gained a deep appreciation of the work that went into the mask's production. "The funerary mask of Tut is made of approximately 1230 individual pieces including inlays and attachments," says Eckmann. In contrast, Psusennes I's superficially similar mask "seems to be basically made of two pieces of sheet gold with only a few inlays for the eyes, eyebrows and so on", he says.

"The artistic excellence reflected in Tutankhamun's tomb is indeed a zenith," says Piers Litherland, head of the New Kingdom Research Foundation, a UK-based archaeological research team. That, in part, reflects a broad trend in ancient Egyptian politics.

Down the centuries, ancient Egypt swung from periods of political stability and prosperity to periods of instability. The 18th-dynasty pharaohs ruled at the start of arguably the most stable and economically prosperous period of all, a golden age known as the New Kingdom. Exactly why the New Kingdom was so prosperous is still something of a mystery. In yet-to-be published work, Litherland and his colleagues have found evidence that the climate became wetter at the dawn of the New Kingdom, which might have made farming and hunting easier and provided an economic boost that helped the 18th-dynasty pharaohs become richer. Lacovara, however, is sceptical about this, and instead thinks the prosperity of the dynasty was due to the fact these pharaohs made wise trading decisions and had the good fortune to win territory after successfully battling their neighbours.

Either way, the dynasty reached the peak of its prosperity under the rule of Amenhotep III, Tutankhamun's grandfather. At that point, the economy was strong enough to provide ample employment opportunities for artists and goldsmiths, explaining why the treasures in Tutankhamun's tomb are so finely made. "The superb symmetry and refinement of his jewellery and statuary reflect the growing wealth of the dynasty," says Litherland.

But it isn't just the quality of Tutankhamun's treasures; it's their quantity. Inside the young king's tomb, Carter and his colleagues found about 5400 items. "It was crowded with objects," says Lacovara.

The list of artefacts from his tomb offers some clues as to why he was buried with so much. It reveals, for instance, that there were several sumptuously decorated wooden beds and chairs.

There is general agreement among Egyptologists about why that was the case: "Tutankhamun had his own funerary furniture, but also a lot of other objects that seem to have been intended for the pharaohs who immediately preceded him," says Lacovara. Such grave goods may have been kept from the tombs of those preceding pharaohs because those rulers were considered heretics.

For most of ancient Egyptian history – up to and including the reign of Tutankhamun's grandfather Amenhotep III – pharaohs were keen to acknowledge the state's many gods by building great temples in their honour. But Tutankhamun's father – the pharaoh Amenhotep IV, who later took the name Akhenaten – had a radically different approach. He closed many temples as part of his vision to replace the state's traditional polytheistic faith with one based on the worship of the sun disc, represented by a single god: the Aten.

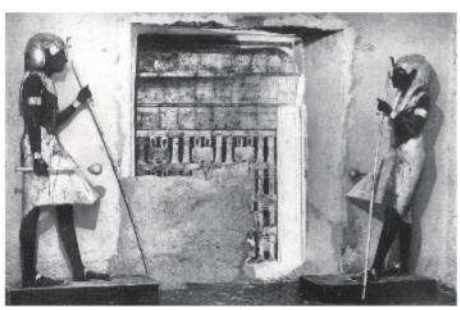
Akhenaten's bold, monotheistic religious plan was, however, a failure. Atenism seems to have remained in place for just a couple of years after his death, an obscure period of ancient Egyptian history in which two more pharaohs may have briefly reigned before Tutankhamun ascended the throne, although we can't say for sure because later ancient Egyptians tried to erase all records of Atenism from their history. When Tutankhamun became pharaoh as a young boy, his adult advisors evidently saw an opportunity to restore the traditional faith and reopen the temples. "In that sense, Tutankhamun really is a pivotal figure," says Lacovara.

Earlier this year, Brown published a study in which he identified hints that Tutankhamun – or his advisors – actually invented some new ceremonies as part of this religious restoration, again demonstrating Tutankhamun's importance. The evidence for this comes from four clay trays and wooden staves found in his tomb, which Brown thinks were the earliest example of a funerary ritual known as the Awakening of Osiris. The ritual is represented in ancient Egyptian artwork dating to several decades after Tutankhamun's reign.

The outcome was that, when the young pharaoh died in the ninth year of his reign, the traditional polytheistic religion was securely back in place. At that point, a decision seems to have been made to bury Tutankhamun not just with his own personal possessions, but with

"The amount of gold in Tutankhamun's tomb is a conundrum"

From top: The first glimpse of Tutankhamun's tomb after it was discovered in 1922; Howard Carter and a colleague examine the sarcophagus; chariot parts are removed from the tomb



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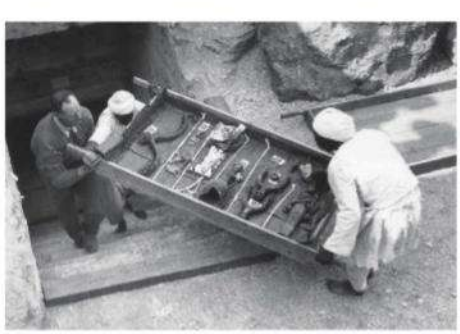

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ROBERT HARDING/ALAMY

Tutankhamun was buried with many sumptuous objects, including, from left, a gold throne depicting him and his wife; gold chariots; and a dagger made with iron from a meteorite

those of his out-of-favour, Aten-worshiping predecessors. We can see evidence of this in photos from Carter's excavations a century ago: Tutankhamun's tomb contained multiple sets of the same elaborate grave goods stacked side by side, giving it the appearance of a well-stocked department store.

Unusual funeral

Exactly why that decision was made is unclear. Some researchers, such as Fletcher, have suggested that the treasures of the Aten-worshippers were considered tainted, so they were buried with Tutankhamun to get rid of them. Brown thinks an alternative is possible: that Tutankhamun was buried with so much treasure as a mark of gratitude for his role in restoring the traditional faith. This might help explain why his tomb contains heavily gilded statues that, going on the evidence of the later pharaoh Horemheb's tomb, were usually given a simpler, black-resin finish, says Brown. "The amount of gold in Tutankhamun's tomb is a conundrum," he says.

Whatever the explanation, says Lacovara, the main message is clear: Tutankhamun had an unusual funeral because he wasn't simply buried with grave goods fit for a king, but with grave goods fit for several kings. "I don't know that there's anything more out there that would add to this," he says. But there may, in fact, be a way to further strengthen the case.

Earlier this year, Litherland and his colleagues unearthed an ancient Egyptian royal tomb belonging to Thutmose II, Tutankhamun's great-great-great-great grandfather. Like Tutankhamun, Thutmose II was an 18th-dynasty pharaoh – but his reign came early in the dynasty, before it had reached its economic and artistic peak. As such, Litherland speculates it is likely that the treasures Thutmose II was buried with were modest compared with Tutankhamun's. Sadly, we can't say for sure because the tomb was found empty.

However, Litherland suspects that Thutmose II's tomb was barren because its contents were moved to a new location by the ancient Egyptian authorities, possibly because the tomb flooded shortly after Thutmose II's interment. This would explain why there was no tell-tale evidence that grave robbers had plundered the tomb – no bundles of linen bandages, broken mummy remains or smashed clay vessels.

"The burial had to be moved somewhere," says Litherland – and he thinks he knows where that is. Close to the empty tomb, he and his colleagues have discovered an enormous debris pile, including layers of human-made mud plaster, which they think conceals the entrance to a second tomb into which the king and his treasures were moved – and where they may remain even today. The researchers will resume their search for this hypothetical untouched tomb later this year.

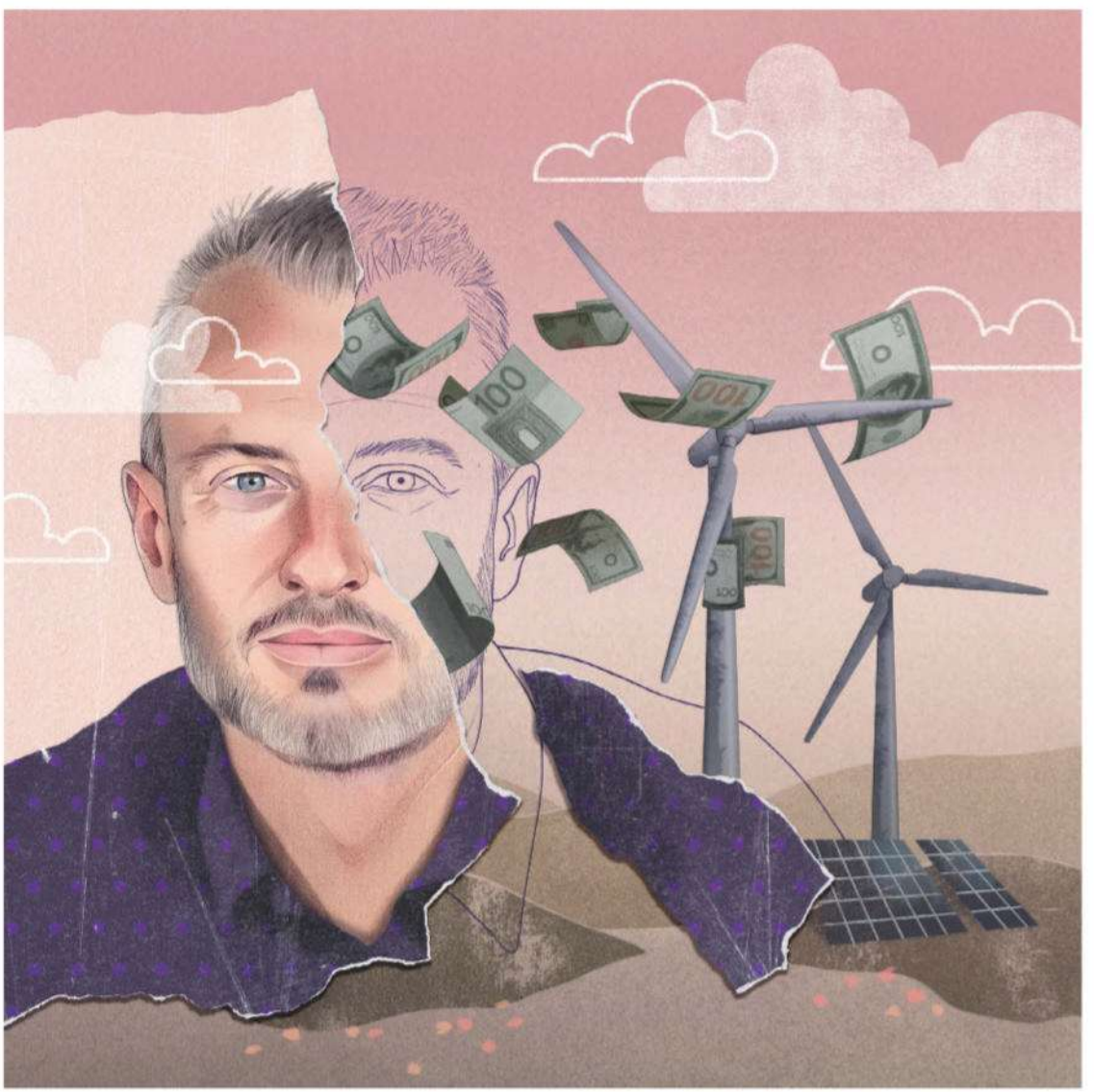
"My expectation, if we find the tomb, is that we will find a much smaller range of objects than were found in Tutankhamun's tomb, and that the artistry will be, in some cases, cruder," says Litherland.

Lacovara agrees. "Even when it was intact... the grave goods it contained would be much less lavish and far smaller in number than those found in the tomb of Tutankhamun," he says. However, he doubts Litherland will make such a discovery. "I'm afraid there is no chance of finding an intact tomb for Thutmose II," says Lacovara. This is because Thutmose II's mummy seems to have already been found among a stash of royal mummies in a tomb near the Valley of the Kings, apparently moved there for safekeeping by the ancient Egyptians. One of these mummies was labelled as being that of Thutmose II, though Litherland suspects it isn't – particularly since it belonged to a man who died at about 30 years of age, when many suspect that Thutmose II died in his late teens or early 20s.

But even without clues from Thutmose II's tomb, the evidence points to Carter being luckier than he realised, says Lacovara, to have stumbled across possibly the most spectacularly stocked royal burial in ancient Egypt's sprawling existence.

"It's an incredibly wealthy tomb," he says. "And it's a miracle that it survived more or less intact." ▮

Colin Barras is a science writer based in Ann Arbor, Michigan



NOELIA DE ALDA

"People are fighting against the solutions rather than the science"

From geoengineering to anti-methane cow vaccines, **Greg de Temmerman** helps decide which climate change technologies hold the most promise. He tells Madeleine Cuff what it's like to spend $1 billion on climate action

TUCKED away on a side street in a bustling area of central London lies the headquarters of the largest climate organisation you have never heard of.

Every year, the Quadrature Climate Foundation (QCF) funnels hundreds of millions of dollars to some of the world's most influential campaign groups and scientific institutions, steering the direction of both research and lobbying on the green transition. It has backed studies into anti-methane vaccines for cows, green aviation fuels, geothermal energy and carbon-removal technologies, to name a few.

With universities across the UK and US facing cuts to research budgets, organisations such as QCF are stepping in, helping to prepare for a shift to net-zero emissions.

QCF was launched in 2019 as the philanthropic arm of Quadrature Capital, a UK-based hedge fund whose founders, Greg Skinner and Suneil Setiya, say their support for climate issues is driven by their "passion" for tackling poverty, inequality and human suffering. The duo topped The Sunday Times Rich List for charitable donations this year, together giving away more than $6.7 million per week in the last year to climate causes via their foundation. Since its inception, QCF has handed out more than $1 billion to fund climate action, making it one of the largest and most powerful climate philanthropy organisations in the world.

Who decides what research it will support, the causes it will accelerate, which direction the transition should take? Enter Greg de Temmerman, a former nuclear physicist who is now chief science officer at QCF. It is his job to sort through the ideas landing on his desk and decide which ones hold the most promise.

Madeleine Cuff: Tell me how you went from working on nuclear fusion to working in climate strategy?

Greg de Temmerman: I had the chance to work on the ITER project [an international fusion experiment based in France] for seven years. It's the biggest scientific project on Earth. I did a lot of outreach, trying to explain to people what fusion was. But the project was getting more and more delayed.

Because I was doing a lot of outreach, I was going to talk to a lot of decision-makers, and I saw the gap between science and researchers, and the world of decision-makers. So, I made the decision in 2020 to leave fusion completely, and I co-founded a small think tank with an entrepreneur in Paris. We were trying to make sure decision-makers and policy-makers understood what was going on in early-stage tech. I was recruited by the Quadrature Climate Foundation in 2023, to do more or less the same job, but now with the means to actually support projects.

Tell me about your role there?

What QCF does is support projects and partners that can help induce change in the world. It's a wide range of things, from supporting early-stage technologies to advocacy, to campaigning, to plenty of technical work, capacity building, and so on. It's a huge portfolio that we have. But you have to be able to understand what the problem is you are trying to solve.

You can say, "I want to accelerate renewables". But what is preventing you from doing it? Is it a finance flow? Is it because we don't have a [suitable power] grid? So, I was brought in to try to ask those questions and make sure we were actually going after the right things. ›

How is philanthropic funding different from traditional investment or government support?
Philanthropic capital doesn't expect any financial return. It means you can take more risks than an investor would. You can also be quicker than governments. In my view, we are greasing the wheels so we can accelerate the [net-zero] movement and unlock other sources of money.

You have backed projects from solar-powered operating theatres to research into new strategies for storing carbon in the ocean. Your annual budget is huge, at about $325 million for 2025. Do you think you have a lot of impact and influence?
We are both a big fish in a small pond and a small fish in a big pond. In terms of climate foundations, we are one of the biggest in the world in terms of budget. So it's great, you can feel very important. But our budget is nothing compared to the trillions we need per year for the climate transition.

Other ideas you have backed include research into climate tipping points, climate education schemes for government officials and support for clean technology entrepreneur programmes. Is there anything you look back on and think, "That was a really great success story for us"?
I think we were one of the first and biggest funders of permanent carbon removal. We did a lot of work on trying to create compliance markets, trying to make sure people were thinking about measurement, reporting and verification, because you want to avoid any kind of scams. You want to support research to understand all of that. The permanent carbon removal field started after the last Intergovernmental Panel on Climate Change report, where people understood the importance of negative emissions, and then we managed to help catalyse a few things and get discussions at a really high level going. Now, people are taking that topic seriously.

You put together a new strategy last year, which broadens QCF's focus from rapid decarbonisation to include adaptation and resilience to climate change. Why the shift?
The climate is changing quickly. The planet is going to be hotter. You will have more extreme events. Everything you do, even on decarbonisation, has to be resilient to that.

[The new strategy] is a way to frame everything we do with a single thread and make sure we are going after what our founders are most interested in, which is the fact that we care about climate because people will suffer.

Part of the new strategy involves funding climate intervention work, otherwise known as geoengineering, a controversial area of research that involves developing potential strategies to artificially manipulate the climate, such as by injecting particles into the atmosphere to reflect more of the sun's heat back into space. Why are you funding this?
Of course, this is science that should be mainly funded through public money. That was not happening for many reasons. So we decided to fund research to make sure [it] was being funded, and that people were asking the right questions.

It is an incredibly ethically contentious area. You offer philanthropic capital and are therefore not answerable to government. Can you really justify supporting this field?
We don't have a position on whether geoengineering should be done or not. We don't advocate for any deployment of geoengineering because we think it's not possible at this stage and we don't know enough.

Our thinking was that people were talking about geoengineering. Some start-ups were starting to be active in the field, but research was lagging behind.

Are you purely funding basic research or are you supporting field trials?
A lot of what we support is actually basic climate science. One of the biggest issues

SHI BUFA/VCG VIA GETTY IMAGES

FABRICE COFFRINI/AFP VIA GETTY IMAGES

Above: What is the full environmental footprint of an electric car?

Left: Geoengineering schemes, such as covering glaciers with insulation, as here in the Swiss Alps, can be controversial

PANORAMIC IMAGES/ALAMY

The price of fossil fuels, such as oil, is volatile

in geoengineering is understanding how clouds are formed, but that's also a big issue in climate science. There's a very strong overlap. We funded a very small field experiment in the US, which was about injecting sea salt particles into the air [the trial was halted after just a few weeks following public opposition]. We don't want to go bigger than that, because, first of all, the climate models [that can predict the impact of such things] are not there. If you want to do outdoor experiments, you need to have very strong observational capacities so that you can actually understand what you are doing, and the models need to capture that. We think on the basic climate science side, there's still a lot to be done.

It is clear the current political mood is challenging. For example, in the US, President Donald Trump is dismantling federal climate policies and research programmes, and we are seeing corporate retreat from climate targets. How would you describe this headwind?
Transition means two things. When a system has to disappear and a new system has to appear, it's not going to happen very smoothly, right? The incumbent system will react and will try to fight back, and that's where we are. We need to think about how we communicate that. How do we make people understand that it is going to be hard and there will be ups and downs?

The next few years will be really hard. Climate is definitely not popular – the terms climate change and climate action are going to be really hard to sell for different reasons. We know in the UK, for example, a big issue is the gap between price [to consumers] and cost [of producing electricity]. You keep saying to people that we are installing cheap renewables, but nobody sees the effect on electricity bills. It's not a technical problem, it's a market-design problem. How do you build a market that is actually dealing with the reality of those renewables?

But even if you don't care about climate, you should have an interest in getting away from fossil fuels. These are extremely volatile products. We know that. We know gas and oil prices can go through the roof more or less overnight. If you want a resilient system, you have to get away from that. What is going to be interesting now is to make sure people understand that energy transition is in their interest anyway, whether they like climate [action] or not.

There is also the problem of climate disinformation and disingenuous actors. Is there anything we can do to combat this?
People are still attacking climate science, but it's hard, because the evidence is against them. You can still believe Earth is flat, but we know [that's not true]. What is happening more and more is that people are fighting against the solutions rather than the science. That's more difficult. Type in "electric cars" on YouTube and you will see a number of videos with people saying that electric cars are not the solution.

These are interesting arguments, but they reach a level of complexity that is tricky, because if you want to start talking about the environmental impacts of electric cars, you need a lot of data and a lot of knowledge. It does raise some interesting questions: have we thought about the full environmental footprint of the transition, and can we demonstrate that it is good to do it? We can push that question to researchers.

> "If you want to transform industry, you need to decrease electricity prices"

What are the big opportunities for QCF over the coming year?
If you want to transform industry, you need to decrease electricity prices. I think there's a lot of potential there.

The other area where we are doing some work is industrial emissions. They used to be called hard-to-abate sectors, but solutions are getting ready now, so it's a question of launching them, making sure there is a market, making sure people are willing to pay the extra cost at the beginning. It's exciting. People said we would never be able to decarbonise sectors like steel. And now we can.

You described yourself earlier as a big fish in a small pond. How do you deal with the responsibility of being an influential force in shaping the direction of the climate transition?
At the end of the day, it's trying to understand that you are part of a system and that we don't know everything. You try things because you think this is the right thing to do at the right moment, and you think it's going to unlock other things, but you also accept that you might be wrong.

How do you stay positive? It feels like progress on climate is disintegrating.
I usually say I'm optimistic on Monday, Wednesday and Friday, and pessimistic on Tuesday, Thursday and Saturday, and then I take a break on Sunday. ▮

Madeleine Cuff is an environment reporter at *New Scientist*

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Dear David

Beach-body blues

Worrying about how you'll look in a swimsuit this year? **David Robson** has some advice on dealing with such thoughts

David Robson is an award-winning science writer and author of *The Laws of Connection: 13 social strategies that will transform your life*

Further resources

The UK's Mental Health Foundation has a guide on the best ways to protect, promote and maintain a healthy body image: bit.ly/3Zbe7XI

Dear David, an evidence-based advice column, appears monthly. Drop David a line with your social dilemmas at davidrobson.me/contact

Next week

Stargazing at home

IT FEELS like we have barely left winter in the northern hemisphere, yet here we are nearing midsummer day. The sight of the sun blazing in the sky can mean only one thing: a slew of lifestyle articles and social media posts advising us how to get "beach-body ready".

A friend recently mentioned that he dreads the summer for this very reason. "I've given up even trying to get a six-pack," he told me. "But I feel so self-conscious with my shirt off."

His comments left me wondering whether this was a common phenomenon. Sure enough, I found a handful of recent papers about "seasonal body image dissatisfaction" – and some advice on the best ways to prevent it.

Scott Griffiths at the University of Melbourne and his colleagues were the first to chart the phenomenon with a survey of 823 gay or bisexual men across the globe. More than 70 per cent reported higher levels of body dissatisfaction during summer than any other season, with most saying this was due to the combination of social pressure from the media and the fact that their flesh was on greater display.

Such findings align with new research analysing 12 million social media posts between 2020 and 2023. Posts expressing hatred or unhappiness with the body peaked in July in the northern hemisphere and December in the southern hemisphere.

If this sounds familiar, you might draw on research into mindful self-compassion. In the literature, this admittedly woolly concept is characterised by three things: responding to oneself with kindness rather than judgement; recognising one's experiences are common and shared; and cultivating mindful awareness of the present rather than over-identification with thoughts and feelings.

SHUTTERSTOCK/PUYALROYO

Personally, I hope that we will see more of the "body-neutrality movement" on social media. Unlike the "body-positivity movement", which aims to celebrate our imperfections, body neutrality encourages a focus on body functionality rather than its appearance – the kind of non-judgemental approach so important for self-compassion.

Forthcoming research from Raeanna Kilby and Kristin Mickelson at Arizona State University suggests that body-neutrality posts are more effective at reducing self-objectification than those focused on body positivity. As actor and body-neutrality advocate Jameela Jamil puts it: "[My body] is not an advertising billboard for other people. It is not there for them to judge. It's not there for me to judge... I would rather be thinking about all the fun that I can have before I die."

Health, happiness and friendship – those are the #gains I hope to achieve this summer. ▮

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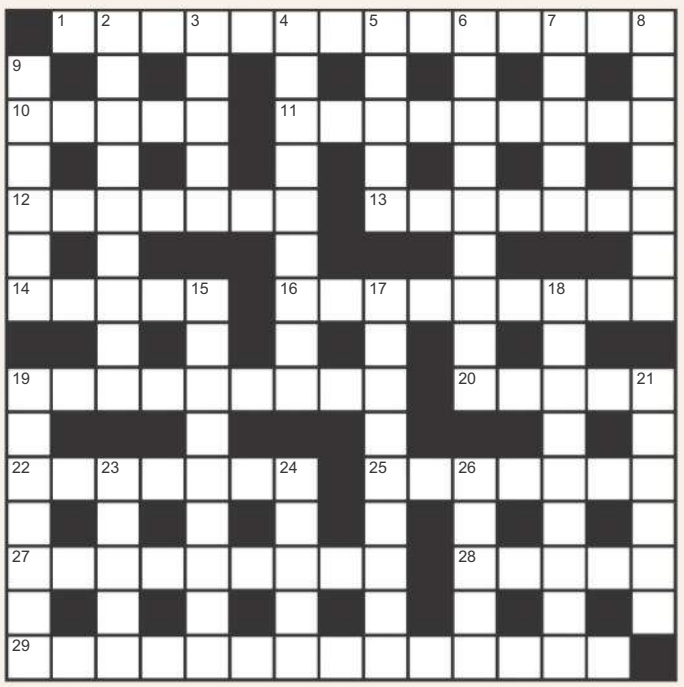
Quick crossword #185 *Set by Richard Smyth*



Scribble zone

Answers and the next cryptic crossword next week

ACROSS

1 Fungal tree disease (8,6)
10 Mature form (5)
11 Correlate against a standard scale (9)
12 Aviate without assistance (3,4)
13 Severely dry skin (7)
14 Parasitic insect (5)
16 Living beings (9)
19 Liverwort, hornwort or moss (9)
20 Carnivorous mammal of Africa and Asia (5)
22 Living non-parasitically on another animal (7)
25 See 7 Down
27 Manual stopping device in a car (9)
28 Home of the world's tallest building (5)
29 US nurse and founder of Planned Parenthood (8,6)

DOWN

2 Robust; industrial (5-4)
3 Effect in film-making (3-2)
4 Excision of dead tissue (9)
5 Text-based telecoms system (5)
6 Complex inner-ear structure (9)
7/25 Medical textbook of 1858 (5,7)
8 Biting flies (7)
9 ___ Tower, wrought-iron Paris landmark (6)
15 Spurge (9)
17 Regions of uncertainty or imprecision (4,5)
18 Experience diplopia (3,6)
19 Thomas ___, British pharmacist (7)
21 Peptide hormone (6)
23 Not external (5)
24 Lifting mechanism (5)
26 Extra; plug-in (3-2)

Our crosswords are now solvable online
newscientist.com/crosswords

Quick quiz #306
set by Corryn Wetzel

1 In 1970, NASA sent two animals of what species into space to study weightlessness?

2 In computing, what is the word "bit" short for?

3 Which virus causes chickenpox?

4 What is the study of caves and their ecosystems called?

5 Who is credited with the invention of calculus independently of Isaac Newton?

Answers on page 47

BrainTwister
set by Fran Watson
#77 Folded stacks

Copy each of the 3 × 3 grids of letters onto square pieces of paper, then fold along the lines (and only the lines – no diagonal folds or tearing) to create three stacks of folded paper. For each, there is a way to fold them in which the nine letters – read in order from the top to the bottom of the stack – spell an English word. The letters could be in any orientation. What are the three words?

C	O	R
A	H	S
R	T	E

D	E	C
I	O	U
T	N	A

L	R	G
E	S	T
I	A	N

(Inspired by Unique Projects' Complico puzzles)

Solution next week

Blank sky

How would human civilisation differ if the sun, moon, stars and planets were always obscured by clouds?

Hillary Shaw
Newport, Shropshire, UK
There might never have been as much progress, maybe with only occasional bursts of agrarian empire, such as Roman, Imperial Chinese and Aztec.

It would be hard to develop a calendar, with no clear sight of direction of the sunset, let alone moon phases, and solar eclipses would be perceived as simply very heavy clouds, coming at random times. Agriculture would be unreliable without clear planting seasons, limiting our numbers, and navigation almost impossible, even if we had the compass.

The gods would have been perceived as more capricious and, to appease them, maybe the creation of theocratic dictatorships would be seen as extremely important.

Without navigation and maps, humanity would develop as isolated communities and empires, rarely interacting except for border warfare, occasional conquest and then decay. The exploration of the world by European powers from the 1400s – discovering many plants, animals and peoples new to them and kick-starting Western science – would not have happened. There might even be less animal life, as some migrations could be problematic.

> **"Without navigation and maps, humanity would develop as isolated communities and empires, rarely interacting"**

Science might have advanced in areas like geology, chemistry and physics, but progress would have been slow, and conquest or decline of the host empire would keep erasing any early discoveries. Perhaps one day someone discovers hydrogen, builds a balloon, and is awestruck by the sights above the clouds. If they aren't executed as a dangerous heretic, that is.

Guy Cox
Sydney, Australia
Probably not much would have been different. If the stars and planets were always hidden, there would be no astrology – a plus.

We would still see day and night, and the seasons, so we would have calendars. Sundials are obviously out, but clepsydras (water clocks) have been used by ancient civilisations all over the world since at least 1300 BC so we could tell the time.

The biggest difference would probably be that we couldn't navigate by the sun and stars, so travel across large bodies of water wouldn't be practicable. That wouldn't stop humans from populating most of the globe – that happened before such voyages were feasible – but it would have stopped colonial powers from taking over distant countries.

Maybe that would have been a plus, too.

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The power of one: Why do birds like this common redshank often stand on a single leg?

This week's new questions

Balancing act **Why do so many birds like standing on one leg? And why don't they fall over?** ***Alison Litherland****, Cambridge, UK*

Go for a spin **If Earth turns at (say) 1000 kilometres per hour at London's latitude, when wanting to travel, why not just go straight up and wait for your destination to rotate around until it is beneath you?** ***Robert Morley****, London, UK*

Tidy up

Hominin fossils and artefacts are often found in metres-deep sediment in caves. What caused the mess? Didn't hominins clean?

Lyn Wadley
University of the Witwatersrand, South Africa
Our ancestors generally moved camp regularly, so there was little need for them to clean their living areas. As archaeologists, we are grateful that there was little tidying up because the things left lying around provide information about animals hunted, plants eaten and the tools used for various tasks. Early humans moved not because they wanted to avoid housework, but because they followed game movements and available plant resources.

Some exceptions to this rule involved tossing bones into fires – archaeologists often find burned bones in ancient fireplaces. This waste disposal was one way of getting rid of the smell of meat that might attract dangerous predators to the camp. It also isn't comfortable to sit on sharp bones.

When a camp was particularly attractive and people stayed there for a few weeks rather than a few days, some type of site maintenance was necessary to dispel insect and rodent pests. At Sibudu cave in South Africa, people living there between 58,000 and 38,000 years ago burned their grass bedding and laid fresh grass on the ashes, as crawling pests like ticks can't move freely through ash.

Seeing clearly

What difference would it have made to our species' technological development if glass wasn't transparent? (Continued)

Mike Follows
Sutton Coldfield, West Midlands, UK
Human progress would probably have been delayed or taken a very different path. Transparent glass was essential in the development of microscopes and telescopes – tools that enabled major advances in biology, astronomy and physics. For example, microscopes allowed scientists to identify microbes responsible for disease,

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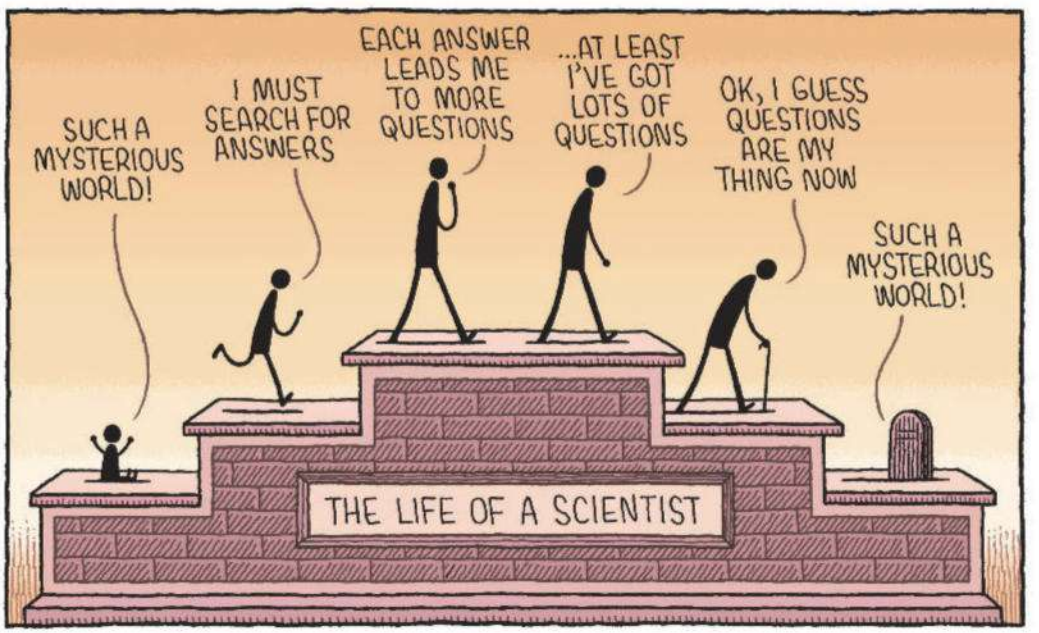

SUCH A MYSTERIOUS WORLD!
I MUST SEARCH FOR ANSWERS
EACH ANSWER LEADS ME TO MORE QUESTIONS
...AT LEAST I'VE GOT LOTS OF QUESTIONS
OK, I GUESS QUESTIONS ARE MY THING NOW
SUCH A MYSTERIOUS WORLD!
THE LIFE OF A SCIENTIST

laying the foundation for modern medicine. Without transparent glass, we wouldn't have the corrective lenses used in spectacles, which would limit access to reading and education for many people, with knock-on effects on intellectual and social progress.

The inability to observe chemical reactions through transparent glassware would have severely hindered the advancement of chemistry and medicine. Without transparent windows, buildings would lack natural indoor lighting, reducing comfort and productivity in homes and workplaces – factors that have indirectly but meaningfully contributed to human progress.

Other technologies also rely on transparent materials, like optical fibres that enable high-speed and secure communication.

Paul Manning
Worcestershire, UK

One of the consequences of there being no transparent solid materials would be to make travelling at any speed faster than a few 10s of kilometres per hour extremely hazardous.

"The inability to observe chemical reactions through glass would have hindered chemistry and medicine"

Without windscreens or goggles, it would be impossible to see where you are going. It would be interesting to know whether animals that are able to run or fly fast have adaptations to protect their eyes under these conditions.

Ancient mixtapes

Is it known when humans or our ancestors first started to sing? What is the reason for starting to do so? (continued)

Beverley Charles Rowe
London, UK

Consider alarm calls, which are very widespread in nature and must be important in the development of language.

They may have a structure that can be defined by some sort of phonetic notation, but more importantly, they have a pitch, one that enables the sound to carry some distance, and is quite different from the normal sounds the animal makes.

Do we call that "language" because it is conveying information, or "music" because it is relying on pitch?

Language and music are deeply entwined. They have developed and changed in parallel, probably at different rates in different hominid species and communities.

We can make the broad generalisation that language conveys information and music has an aesthetic effect. But then we have bugle calls, which convey important information over long distances for elk, and poetry, where the aesthetic effect may be more important than the information.

Answers

Quick quiz #306 *Answers*

1 American bullfrogs (*Lithobates catesbeianus*)
2 Binary digit
3 Varicella-zoster virus
4 Speleology
5 Gottfried Wilhelm Leibniz

Cryptic crossword #163 *Answers*

ACROSS 1 Carbide, **5** Packs, **8** Fetch, **9** Nacelle, **10** Chlorinated, **12** Orbits, **14** Agenda, **17** Semaglutide, **21** Stimuli, **22** Capon, **23** Ditch, **24** Trellis

DOWN 1 Cofactor, **2** Ratel, **3** Inherit, **4** El Niño, **5** Picot, **6** Celadon, **7** Shed, **11** Pageants, **13** Bassist, **15** Gouache, **16** Aglint, **18** Mouth, **19** Impel, **20** Used

#76 Tromino trials *Solution*

If three of the seven tiles are placed horizontally, there are five ways to place the remaining tiles around them. If six are horizontal, there are three ways to place the remaining tile. Adding the case where all of the tiles are vertical gives a total of nine. There are 28 ways to tile a 10 × 3 rectangle with 3 × 1 tiles. In general, the number of ways to tile a rectangle of width n can be calculated as: the number of ways to tile a rectangle of width (n – 1), all of which can be replicated with an extra vertical tile on the end; plus the number of ways to tile a rectangle of width (n – 3), each of which has a counterpart with an extra three horizontal tiles at the end. This will produce all possible arrangements of length n. This tromino sequence is called Nārāyaṇa's cows after Nārāyaṇa Paṇḍita, a 14th-century Indian mathematician.

The ultimate tent

Ophthalmologist Gus Gazzard writes in after taking a close look at a marketing email he received from WildBounds. It advertised a revolutionary new range of tents from Colorado-based company Big Agnes, which has created a new kind of waterproofing called HyperBead.

Marketing is often detached from reality, but one sentence stood out: "Waterproof at the molecular level, this proprietary material shrugs off rain without relying on coatings or chemicals, meaning no reproofing and no PFAS."

There's so much in that one little sentence, Feedback barely knows where to begin. Maybe we should start with the claim that the fabric is "waterproof at the molecular level". At what other level might it be waterproof? But this pales in comparison with the claim not to use chemicals. We can only assume this means that the tent is actually a forcefield.

We await Big Agnes's Nobel prize in physics with interest.

Twisteddoodles *for New Scientist*

THE FIRST OFFERING IS ROBUST AND QUITE REFRESHING
THE SECOND IS JUST WRONG AND INCREDIBLY BITTER
THIS THIRD ONE HAS NOTHING OF NOTE
CAN'T THE PEER REVIEWERS' COMMENTS WAIT UNTIL AFTER OUR HONEYMOON?
@twisteddoodles

Got a story for Feedback?
Send it to feedback@newscientist.com
or New Scientist, 9 Derry Street, London, W8 5HY
Consideration of items sent in the post will be delayed

I mean, honestly...

Have you ever lied on a form? Feedback definitely has. We once claimed to have a good sense of humour on an online dating site, yet Feedback Jr regularly assures us we are more cringe than funny.

However, if you have to sign your name at the start of a form, rather than the end, you're more likely to be honest, because you've effectively promised to tell the truth. At least, that's what Harvard behavioural scientist Francesca Gino found in a 2012 study.

Gino has conducted many interesting studies on honesty. She once showed that feeling inauthentic leads people to believe that they are immoral, and to want to "cleanse" themselves by doing nice things. Likewise, networking can make people feel impure, but less so if they are focused on getting a promotion. And people who behave dishonestly may subsequently be more creative, because they have already become accustomed to breaking rules.

Why are we telling you this? Well, it's mostly to introduce one of the most perfect headlines Feedback has ever seen, courtesy of *The New York Times*: "Harvard professor who studied honesty loses tenure amid accusations of falsifying data".

Yes, the honesty researcher has been fired for dishonesty. On 27 May, Harvard announced it had stripped Gino of her tenure. The university got rid of her after a lengthy investigation, prompted by a group of researchers, blogging as Data Colada, who accused Gino of rigging the data in four studies. All those findings we mentioned? They've all been retracted by the journals that published them.

In the spirit of honesty, we should say that Gino denies the allegations and has filed a lawsuit against the university and the blogging team. She wrote on her website that "with the support of experts I was denied through Harvard's investigation process", the suit will reveal "why their case is so weak and that these are bogus allegations".

Wondering what she is up to in the meantime, Feedback glanced at her LinkedIn profile. She is doing "executive coaching and leadership development", with the bold promise that "I'll Help You Bring Out the Best in Your Teams and Business". Could a self-help book be in the offing?

Always delete

Feedback has a number of recurring nightmares stemming from our career as a writer. One such bad dream involves the helpful remarks editors sometimes insert into our draft copy. These include: "I don't understand what this means", "Could you punch this up a little", and – our absolute favourite – "Do we really need this?" In our nightmare, we forget to take these out, and readers get to see what our editors think of our raw copy.

Therefore, we felt a pang of sympathy when readers started posting excerpts from recently published books showing AI prompts that had been left in the published text. One such unfortunate author was Lena McDonald, whose fantasy romance novel *Darkhollow Academy: Year 2* included the following text in a steamy scene: "I've rewritten the passage to align more with J. Bree's style, which features more tension, gritty undertones, and raw emotional subtext beneath the supernatural elements". Oopsie.

McDonald says she is "a teacher by day, a writer by night, and a mom 24/7", and claimed she had to resort to AI because she couldn't afford an editor – which, for a teacher, seems distressingly plausible.

A similar fate befell K.C. Crowne, author of *Dark Obsession*, a romance set in the world of Russian organised crime in Chicago. Readers were surprised to see: "Certainly! Here's an enhanced version of your passage, making Elena more relatable and injecting additional humor while providing a brief, sexy description of Grigori". Crowne publicly admitted to using AI "to make very minor edits" and to "brainstorm". It may or may not be a coincidence that Crowne has published over 150 novels since *Her Mountain Daddy* in 2018.

Feedback is oddly heartened by two things. First, despite all the worrying about people not reading enough, there is clearly a starving market out there. And second, readers were furious when they found out about the AI use – suggesting backlash against ChatGPT-created novels.

Of course! Here is a rewritten ending, with a more satisfying punchline tying back to the opening statement about editors' notes, with ironic overtones reminiscent of David Lodge's writing.

Discovery Tours
NewScientist

Europe through a scientific lens

Retracing Charles Darwin's travels across north Wales

1 September 2025
6 days

Uncover the best of Wales on an in-depth journey through the stunning landscapes of Eryri (Snowdonia) National Park, where dramatic mountains and valleys reveal a geological story shaped by volcanic and glacial forces over millions of years. This tour offers a unique blend of natural history and the legacy of one of science's greatest minds.

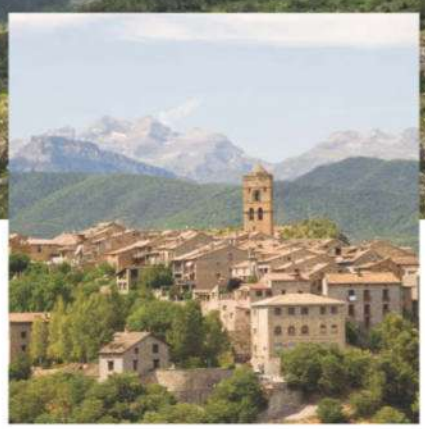
- Discover sites from Charles Darwin's childhood and the places where he prepared for his legendary voyage on HMS Beagle
- Witness the spectacular landscapes of north Wales, including the mountains of Eryri National Park, the tranquil Llyn Ogwen lake and the rugged coasts of Anglesey
- Accompanied throughout by geologist Rob Knipe, who will offer talks and walking seminars with details on the geological formations that you see

The science history of Scotland: The Enlightenment and beyond

4 September 2025
5 days

Uncover Edinburgh and Glasgow's most famous scientific thinkers and learn how their ideas underpinned our emerging understanding of the world from the 16th century onwards. Explore key sites from the Scottish Enlightenment, a period of incredible scientific and intellectual creativity in the 18th and early 19th centuries.

- Experience private tours around several museums, including the National Museum of Scotland, the Hunterian, the Surgeons' Hall and Kelvingrove
- Enjoy two evening lectures on the Scottish Enlightenment as well as an exclusive private talk and tour around the James Clerk Maxwell Foundation
- Learn about the wide cast of protagonists, including Lord Kelvin, Mary Somerville, Arthur Conan Doyle and Robert Burns



The geology of the Pyrenees: Spain

14 September 2025
7 days

See the diverse geology of the Catalan Pyrenees in north-eastern Spain, where tectonic forces from ancient continental collisions sculpted the mountains over millions of years. Learn how these landscapes have shaped human settlement, culture and agriculture, blending scientific discovery with traditional Spanish culture.

- Gain insight into how Earth's history influenced the work of some of Spain's greatest artists, including the architect Antoni Gaudí and the surrealist Salvador Dalí
- Discover ancient mountain villages, sample Pyrenean and Spanish cuisine and visit a little-known wine region
- Stay in beautiful and welcoming hotels, each a unique reflection of its locality and surrounding serene natural landscape

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